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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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[OFFICIAL NOTICE.]

Twenty-ninth Annual Meeting, American Gas Light Association.

OFFICE OF THE SECRETARY,
NEW YORK, Sept. 10th, 1901.

There will be an annual meeting of the American Gas Light Association held at Boston, Mass., October 16th to 18th, 1901.

The meeting will be called to order by the President, Mr. Edward G. Pratt, of Des Moines, Ia., at 10 A.M., on Wednesday, October 16th.

The meeting hall will be Steinert Hall, Boylston street, near Park square, Boston, Mass.

The headquarters will be at the Hotel Brunswick, corner Boylston and Clarendon streets, Boston, Mass.

The most satisfactory quarters are always obtained by writing in advance to the hotel people, and in doing so a reply should be requested, for which a self-addressed, stamped envelope should be inclosed, as misunderstandings may thereby be averted.

The Hotel Brunswick is conducted on the American plan, and rates for rooms will be as follows:

Rooms without bath, occupied by one person, $4 per day; occupied by two persons, $3.50 per day for each person. Rooms with bath, occupied by one person, $5 per day; occupied by two persons, $4.50 per day for each person.

While the Brunswick prefers not to take any of the members of the Association on the European plan, and has not made any rate on this plan, members who are especially desirous of adopting it may be able to make special arrangements by communicating with the hotel management.

The Lenox Hotel, corner of Boylston and Exeter streets, makes the following rates on the European plan: Single rooms, $1.50, $2 and $2.50; single rooms with bath, $2.50, $3 and $3.50. Double rooms, $2.50, $3 and $4; double rooms with bath, $3, $3.50 and $5. Both hotels are within 5 minutes' walk from Steinert Hall.

Other hotels at Boston are as follows: Copley Square Hotel, Huntington avenue and Center street; Hotel Thorndike, Boylston and Church streets; Hotel Touraine, Boylston and Tremont streets; Adams House, Washington street, south of West street; Parker House, Tremont and School streets; Young's Hotel, Court street.

The Roll Call will be made by means of the door card system. Each member upon entering the hall for the first time will at the door receive a special card upon which he will find his name, address, etc., as on the Secretary's books, and such card should be corrected and given to the doorkeeper. Members in attendance should attend to this very carefully, as these cards are used immediately after the meeting for correcting the annual membership list. Visitors will please hand to the doorkeeper their personal cards.

A blank form of application for membership accompanies this circular. More can be obtained of the Secretary. Remember, all applications must be in the Secretary's hands by October 6th, at the very latest, otherwise they will not be acted upon at this meeting.

The list of papers to be read at the meeting is as follows:

"The Analysis of Gas Accounts," by Mr. Paul Doty, Detroit, Mich.

"What is a Gas Company's Business?" by Mr. Frank D. Moses, Trenton, N. J.

"Tar and Water from Water Gas," by Mr. Wm. E. McKay, Dorchester, Mass.

"Retort Ovens as Producers of Illuminating Gas," by Mr. T. Littlehales, Syracuse, N. Y.

"Further Notes on Retort House Practice," by Mr. E. H. Earnshaw, Philadelphia, Pa.

A paper by Mr. A. B. Slater, Jr., Providence, R. I., and a paper by Mr. C. F. Prichard, Lynn, Mass. The titles of these last 2 papers have not yet been announced.

If the papers are of a sufficiently high standard the Beal Medal will be awarded to the author of the best paper presented; the question of which is best to be decided by the proper committee.

LIBRARY OF CONGRESS
SEP 16 1901
SMITHSONIAN DEPOSIT.

The officers are endeavoring to arrange for a lecture on some subject of interest to the members to be delivered during the meeting.

In addition to the papers and lecture, the Report of the Research Committee will deal with the question of "Pipe Standards" referred to the Committee at the last meeting, and with other subjects that should give rise to a good discussion.

During the days of the meeting all the announcements will be posted on the bulletin boards in the hotel. All members are warned to take notice thereof accordingly.

All members attending the meeting are particularly requested to wear their membership badges in plain sight, thereby greatly aiding the officers and the local committee in their work, by affording a ready means of recognition.

In order that the "Year-book" containing the report of this meeting may be published and issued to the members immediately after the meeting, notice is hereby given that, if any of the speakers at this meeting desire to correct their remarks before they are printed, they will be given an opportunity before leaving Boston, Mass., but not after. The stenographer will have typewritten copy of the principal discussions prepared at the headquarters between the sessions of the meeting, and all those who desire to correct their remarks must notify the Secretary at the close of the session at which such remarks are made, as all the reports will be turned in to the printer immediately after the adjournment of the meeting.

The arrangements for the entertainment of the members and the ladies accompanying them during the meeting have not yet been completed. The entertainment will, however, include a banquet at the Brunswick, the evening of Thursday, October 17th, and an excursion of some kind on Friday, October 18th. It is also probable that the ladies will be taken on a trip around Boston, during which they will be in charge of a thoroughly competent guide and be shown all the places of historic interest. A complete programme of the entertainment will be given in an announcement to be sent out later.

Any members having questions which they desire to put into the Question Box should send the same to the Secretary as soon as possible, in order to give him an opportunity to have them printed and distributed to the members before the meeting so as to secure for them careful attention.

ALFRED E. FORSTALL, Secy.

BRIEFLY TOLD.

OBITUARY NOTE—MR. WALDRON SHAPLEIGH.—We regret to have to report the death of Mr. Waldron Shapleigh, Chief Chemist to the Welsbach Company, who passed away, at his summer home, West Lebanon, Me., the morning of the 30th inst. Deceased, who was a son of the late Mr. Marshall Spring Shapleigh, of Philadelphia, was born in that city in 1848. At an early age he manifested so strong an inclination for the study of chemistry, that his parents agreed to fit him out thoroughly for that profession. His first instruction therein was obtained under the tutelage of the late Professor Williams, and so apt was he that, when in is 19th year, he felt equal to assuming the duties of Chemist to the Blair County (Pa.) Zinc Works. At 20 he entered the Lehigh (Pa.) University as Instructor of Chemistry, under the direction of Profes or Wetherill, and on the death of the latter succeeded to his position. During his professorship at Lehigh University, his interest was attracted to the chemical problems involved in the production of sugar from beets, which problem was then prominent in the consideration of the scientific world. Resigning his place in the University, he went to France, and there, in a course of 2 years' training, obtained a complete knowledge of the principles and practice involved in the manufacture of sugar from beet roots. Returning to America, he was retained as Chemist to the Kings County (N. Y.) Sugar Refining Company, with which concern he remained until its absorption by the American Sugar Refineries Company. His next position was that of Chief Chemist to the Welsbach Company, which he served with distinction to the time of his death. He was a member of the English Chemical Society, of the Society of Chemical Industry and of the Society of Arts; and was also a member of the American Chemical Society and of the Franklin Institute. Other memberships of his of a social nature were his affiliations with the Markham and Country Clubs, of Philadelphia, and the Century Club, of New York. Mr. Shapleigh was a man of excellent ways, and in his mental strength was never unmindful of the seemingly lesser ties that bind us all together in the webs of respected and enjoyable comradeship. He is survived by a widow, a son and a daughter. For the facts in this brief narrative of the history of Mr. Shapleigh we are indebted to Mr. S. Mason, of the Welsbach Company.

The Buffalo Tandem Gas Engine.

The Alberger Company, of Buffalo, N. Y., at the Pan-American Exhibition, is showing an exhibit of one of its Buffalo tandem gas engines in the center court of the Machinery Building. It is belted to a Roots' rotary pump, and, in order to perform this work, the engine is loaded to 122-brake horse power, this load being carried daily from 10 A.M. to 10:30 P.M. The engine is operated with natural gas and is rated at 125-brake horse power. It is of the 2-cylinder type, with the single acting cylinders arranged horizontally in tandem, giving it an appearance similar to a tandem steam engine. The bore of the cylinders is 17 inches, the stroke is 19 inches, and the speed of the engine is 190 revolutions per minute. The engine has an exceptionally strong and substantial appearance, and operates with the steadiness of a steam engine, and without any vibration. The manufacturers have realized that the steam engine has met with universal use because of its reliability and adaptability to meet without trouble largely varying conditions of load and service. It has, therefore, been their main object to place on the market a gas engine which comprises these features of the steam engine, and in addition furnishes an exceptionally economical source of power.

The cylinders are cast, of hard-grained iron, and are thoroughly water jacketed, and in such a manner as to render it impossible for water or air to become pocketed in the jackets. The frame is a heavy, box-type casting, strongly braced, and has great rigidity. The material is so disposed between the main bearings and the cylinder yoke that the working stress is carried in straight lines. The frame is extended under the cylinders to a pedestal support, designed to carry only the weight of the cylinders. The working stress from the rear cylinder is communicated directly through the metal to the front cylinder in straight lines to the main bearings. The main bearings, which are of remarkably generous proportions, are split at an angle so that the rigid frame and not the cap is presented to the thrust. The bearings are lined with genuine Babbitt metal, securely anchored, thoroughly hammered and accurately bored. The fly-wheels on this engine are 78 inches in diameter, with a face of 6 inches. The driving pulley is bolted to the spokes of one fly-wheel.

The crank shaft is 6¼ inches in diameter by 6 feet 2¼ inches long. It is a 1-piece, open-hearth, homogeneous steel forging, to which are secured 2 cast iron counter-weight disks. These disks are so proportioned as to secure a correct running balance of the engine. The connecting rod is an open-hearth, steel forging of rectangular cross section, having marine type crank-pin box. The method of attachment to the piston permits easy removal of the rod when desired.

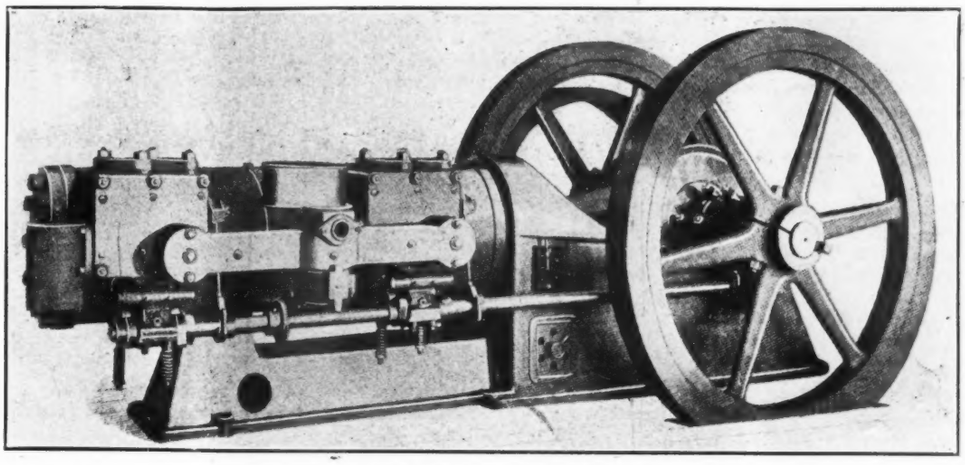
The pistons are single acting and are carefully fitted with special cast iron self-adjusting packing rings. Undue heating of the pistons is prevented by reason of one side of each piston being exposed to the atmosphere. Simply removing the rear cylinder head allows the reciprocating pad to be readily removed for examination and cleaning.

On one side of each cylinder is securely bolted a valve chest, which contains the admission valve and the exhaust valve necessary for the operation of that cylinder. From the lower side of the valve chests, and integral with them, projects the cam-shaft hanger. On the top of each chest are 2 handhole covers, one being over the admission valve and one over the exhaust valve. These covers are easily removed; one is equipped with relief valve and the other is tapped for indicator connection. The admission and exhaust valves are of the vertical poppet type and positively actuated.

The cams operating the valve mechanism are rotated upon a 2½-inch diameter steel shaft, conveniently placed along one side and lengthwise of the engine. This cam shaft is firmly supported by 3 bearings placed close to the point from which power is delivered to or by the side shaft. The speed of the cam shaft is one-half the speed of the engine, and is driven by a pair of cut helical gears.

The engine is operated on the standard, 4-stroke cycle, the cycle comprising admission, compression, expansion or working, and exhaust strokes, continuously repeated in the order named in each cylinder. The periods, however, are not simultaneous in the cylinders, but are spaced one revolution apart. Thus, if the expansion or working stroke is occurring in one cylinder admission is occurring in the other cylinder; if compression is occuring in one cylinder the exhaust gases are being expelled from the other cylinder during the same stroke. Taking the two cylinders in conjunction, a working stroke occurs for each revolution of the engine. This equal spacing of the working impulses results in smoothness of operation and freedom from vibration.

One of the distinctive features of this engine is its governing device. The gas and air are mixed by suction and intermingling in economical



The Buffalo Tandem Gas Engine.

and proper proportions. Before entering the cylinders, however, this mixture or charge must pass through a cut-off valve, which permits the passage of the charge in an amount or volume accurately graded to the load on the engine.

A practically free suction of the charge to the cylinders is, therefore, permitted during the time the valve is open, avoiding throttling or wire drawing of the charge and consequent friction, and maintaining the exact proportions or quality of the charge through the variations of the load.

The intensity or force of the power impulses, following precisely the action of the governor, gives close regulation.

In consequence of these characteristics the engine is exceptionally applicable to the economical generation of electric current, responding promptly to varying conditions of load on the generator, and for electric lighting, giving steady and flickerless lights.

The relative proportions of the constituents of the charge or mixture may be varied, through the widest possible range, by the simple turning of a thumbscrew; the screw adjustment also permits the most minute variations with micrometer accuracy. In other words, the constituents of the charge may be varied to suit not only the particular gas used in any case, but the adjustment may be made to suit any of the various fuel gases, whether natural gas, illuminating gas, producer gas, furnace gas, gasoline, etc.

The combustible charge is ignited by an electric spark passing between two points when their contact is suddenly broken by means of a trip. The igniters are substantially and accurately constructed. The spark points are made of a practically indestructible alloy, which wears for years. The points are brazed on steel electrodes. The electrodes are held on a solid plug, bolted on the side of the valve chest, directly adjacent to the admission valve. This position of the sparking points in the path of the cool entering charges preserves them from the possible destructive effects of overheating. The plug can be readily removed and replaced; the joint is ground and requires no packing. The trip is actuated by a plain eccentric on the cam shaft.

The construction of this igniter is particularly original, in that the point of revolution at which ignition occurs may be instantly varied at will by the operator, either while the engine is at rest or in operation, and is definitely indicated for any setting of the igniters on an exposed dial.

The most economical point of ignition may be determined by a reference to the gas meter. When starting the engine the igniter is set forward to a definite point, giving easy starting impulses and preventing reversal of the engine; when the engine is up to full speed the igniter is shifted back to a predetermined point for the best economical results.

The igniting current when the engine is running, is supplied by a small dynamo, located on a bracket bolted to the side of the frame, being self contained with the engine. When starting the engine the igniting current is supplied for a moment by cells. The demand on the cells is so short that they last indefinitely without renewals. The cells are inclosed within the engine frame, where they are secluded from liability to damage. The exhaust gases, before leaving the engine, are intimately mixed with the waste-jacket water in a novel and effective manner, which instantly reduces the temprrature and consequently the volume of the exhaust. The discharge of the exhaust to the atmosphere, instead of having the usual loud report, resembles the exhaust from a steam engine in quietness and appearance.

The lubrication of the cylinders and bearings is accomplished simply and effectively; glass body, sight-feed oil cups being used. The crank pin is oiled in a positive manner, the oil being fed from a stationary oil cup, and no wiper devices or movable oil cup are necessary.

It should be noted that the use of tandem cylinders has made possible a design of exceptional compactness, in the convenient grouping of the admission and exhaust valves, the valve chests, the governor and mixing valve, water valve, gas valve, igniters and self-starter on one side of the engine. The concentration of these parts within practically one step of the operator will be readily appreciated by those who have had experience with other types of multiple cylinder engines. At present the Buffalo tandem gas engines are built in sizes ranging from 30-horse-power to 250-horse-power.

The Economical Production of Diluting Gases.

[A paper read by Mr. C. B. Tully, of Sligo, at the Dublin meeting of the Irish Association of Gas Managers, August, 1901.]

From the time when the dilution of coal gas with cheaper gases was first employed, the author has felt the grave importance of the subject. The objections to the use of straight water gas appeared to him far stronger than its advocates are willing to admit. While investigating the subject, he heard Professor Vivian B. Lewes' lecture on "Acetylene and its Modern Development," delivered before the Gas Institute in 1898. As the members will recollect, Professor Lewes then stated that it is possible to make, in a slightly modified water gas generator, a cheap diluting gas of the following composition to be used for diluting acetylene:

	Per Cent.
Hydrogen	45
Carbon monoxide	15
Methane	30
Unsaturated hydrocarbons	5
Carbon dioxide and nitrogen	5
	100

All at once it occurred to the author that such a gas should form a satisfactory diluent for coal gas, especially having in view the subsequent enrichment of the mixture with benzol. Having investigated the subject on the lines stated, he communicated with Professor Lewes. As a result, that gentleman generously put all his experience at the author's disposal. He further furnished the drawings from which the trial plant at the Sligo gas works was erected some 18 months back.

Since that time experiments have been carried on almost continuously. It is, however, only within the last few weeks that sufficiently accurate data have been obtained to form a definite opinion upon the merits of the system. Much time was lost in procuring and arranging the apparatus necessary for making complete analyses of the gases; also in systematizing the laboratory tests, as well as the working of the generator itself. In both cases the operations have been reduced to the simplest routine, well within the capabilities of the average young

assistant. The superiority of such a gas over water gas as a diluting gas is quite evident, and its most fascinating features are its similarity in composition to coal gas, its high calorific value, and the small percentage of carbon monoxide contained in it.

When first erected, the generator was fitted with fire bars; the blast and steam being introduced under the bars, and the oil sprayed in about 2 feet above them. Owing to the peculiar shape of the grate, difficulty was experienced with the bars; therefore the author decided to dispense with them, introducing the blast from 4 points in the circumference of the shell. This arrangement is found to work very well. The clinker solidifies about 4 inches above the blast, and forms a natural grate, open and easily removed. Clinkering should take place about every 8 hours (the necessity for which is ascertained by the blast pressure gauge), and is done by removing the clinker under that just formed, and afterwards breaking down the clinker forming the natural grate, leaving it in the base of the generator for removal at the next clinkering; the generator being cleared out completely every second or third day.

It occurred to the author that it would simplify matters to introduce through the blast nozzle the steam and also the hydrocarbon to be decomposed. Drawing No. 1 shows this arrangement, which is so simple

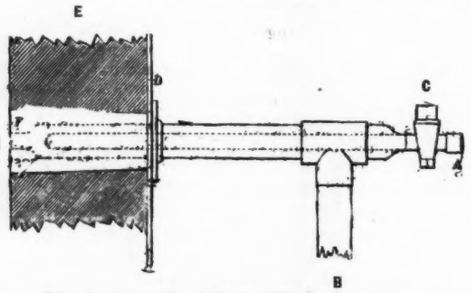


Fig. 1.—Blast Oil and Steam Fitting to Generator.

A—Hydrocarbon and steam supply. *B*—Blast supply. *C*—Stopcock. *D*—Generator shell. *E*—Generator wall. *F*—Cast iron block. *G*—Steam and hydrocarbon. *H*—Blast, etc., to generator.

as to require no explanation. Very great difficulty was experienced in spraying in the hydrocarbon satisfactorily; but this was eventually overcome by the adoption of the steam injector shown in Drawing No. 2.

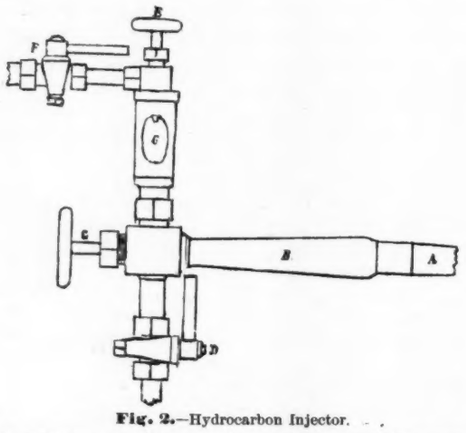


Fig. 2.—Hydrocarbon Injector.

A—Supply to generator. *B*—Mixing chamber. *C*—Steam-regulating valve. *D*—Steam stopcock. *E*—Oil-regulating valve. *F*—Oil stopcock. *G*—Oil sight-feed.

The mixing chamber is fitted internally with a strip of copper having a twist of half-a-turn to give the steam and hydrocarbon a rotary mixing action. Drawing No. 3 shows the general arrangement of the plant. The only difference between it and the ordinary carburetted water gas plant is the form given to the generator by Professor Lewes and the author's method of introducing the blast, steam, and hydrobarbon to the generator. The fuel in the generator must be of sufficient depth or density to filter out or retain all the carbon produced on the decomposition of the hydrocarbon. The carbon passing the generator will be deposited either in the carburettor or in the superheater, and be there consumed during the blow—aiding in the heating of these parts of the plant.

The author worked the Lewes generator for some months, injecting gas oil for the production of a diluting gas. The proportions of steam and oil were varied from time to time, in order to arrive at the best results. Further, complete analyses of the gases were made at every

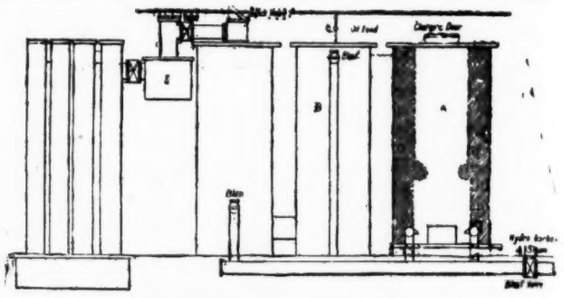


Fig. 3.—General Arrangement of Plant.

A—Generator. *B*—Carburettor. *C*—Superheater. *D*—Hydraulic seal. *E*—Washer-condenser.

trial. At the end of an extended series of experiments, he was forced to the conclusion that the cost of gas oil was too great for the purpose. It was therefore decided that the success of the process must hang upon the possibility of using the tar produced in the works from both the ordinary coal gas and the carburetted water gas plants. He therefore determined to devote his time to settling the question as to whether or not these could be used commercially. It also appeared that a further condition of success is to produce a gas having a minimum of carbon monoxide.

His subsequent investigations were, therefore, conducted with a view to realizing these two objects; and it is believed that the results obtained so far show that a large measure of success has been reached on these lines. Following the course adopted when injecting gas oil, trials and analyses were made to determine the best proportions of steam and tar and the period of injection. It was found that the best results were obtained when running tar and steam for twelve minutes, steam alone for three minutes, and blowing for five minutes; and that with a consumption of about 30 lbs. of coal gas tar per 1,000 cubic feet of gas made, a diluting gas is obtained of the following average composition, before purification:

Carbon dioxide and sulphuretted hydrogen	5.00	per cent.
Hydrocarbons absorbable by bromine.....	2.40	Ethylene, propylene, butylene, etc.
" " " nitric acid...	0.95	benzene vapors.
Carbon monoxide	15.03	
Methane.....	8.00	
Hydrogen	65.50	

So far as can be seen, the tar is completely decomposed into gas and carbon; there being no tar or condensible hydrocarbons whatever from the plant.

The striking points in the composition of this gas are: (1) The very large proportion of hydrogen and benzene vapors; (2) the small proportion of methane as compared with Professor Lewes' anticipations. It may be mentioned that when introducing the tar at the bottom of the generator, it was expected to be completely decomposed into carbon and hydrogen. But such was not the case; and it is quite evident that the tar or other liquid hydrocarbon is well able to look after itself without the assistance of the steam—the latter only being necessary for the purpose of injecting the tar, and the less steam used the less carbon monoxide produced.

At least a hundred analyses have been made of the gases, also of mixtures of these gases with coal gas, and some very unexpected discoveries have been made of the performance of the gases within the generator. These, however, must form the subject of a later communication. The reactions are many and complicated—so much so that the author hopes to persuade Professor Lewes to deal with the subject. The two sets of experiments with gas oil and tar respectively showed that the sole advantage to be obtained by the use of the former in the proportion of 3 gallons per 1,000 cubic feet of gas made, is an increase of 1.2 per cent. of hydrocarbon absorbable by nitric acid, and a slight increase in hydrogen above that given by the same proportion of coal tar. Curiously, whether oil or tar was used, and whether 1, 2, or 3 gallons per 1,000 cubic feet were employed, it was found that the percentage of methane present in the resulting gas was practically the same.

It has been found that the producing capacity of the plant, whether making water gas or the author's diluting gas, is practically the same. The cost of the two processes is also nearly the same, being for 1,000 cubic feet of gas made the difference between the cost of 30 pounds of tar and that of 30 pounds of coke.

The experiments and analyses furnishing data for this paper were only completed and checked within the last few days. The service between the diluting gasholder and the photometer and calorimeter has only just

been completed; hence no tests as to the lighting and heating values of the gas have yet been made directly. Judging, however, from the analyses, the appearance of the flame, and the performance of the diluting gas when mixed with coal gas, the photometric value may be fairly estimated at 8 candles, and the calorific value at about 100 to 120 calories.

Many points of interest have been noted in connection with the use of this diluting gas. To describe these fully, together with the methods of mixing it with coal gas, would far exceed the time allowed for the reading of papers before you. If the subject is of interest to the members, the author will gladly furnish a paper upon it at a later date. It may, however, be mentioned that at Sligo the diluting gas is mixed with the coal gas at the hydraulic main, and afterwards carburetted at the governor with benzol to the necessary illuminating power, before being delivered to the town mains. The results obtained by mixing at the hydraulic main, though eminently satisfactory, throw great doubt upon the predictions of many engineers as to the amount of benzene vapors to be recovered from the tar by this method of mixing.

The diluting gas as made by this process contains, as already shown, a considerable proportion of hydrocarbons. The presence of these hydrocarbons allows of the gas under consideration being carburetted to the same degree as water gas with a much smaller proportion of carburetting oil. Another strong point in favor of this process is the employment of the tar produced in the works by the carburetted water gas and coal gas plants in the generator. The proportion of carbon monoxide present tn this gas is very low as compared with that in water gas; consequently the quantity of the author's diluting gas that can be mixed with coal gas is at least twice as great as that which can be used with water gas. Even then the proportion of carbon monoxide in the former mixture will be lower than with water gas.

Existing water gas plants can be modified at a nominal cost to suit this process. Further, there is no smell from the generator when injecting tar. The labor required for working the generator is somewhat less than in the case of water gas. It is not within the scope of this paper to enter into commercial results. From the facts already given it will be seen, however, that the Sligo Gas Company will have no reason to regret its enterprise in erecting this experimental plant.

In conclusion, the author begs to thank the members for the attention they have given to his paper, and sincerely hopes that his efforts in this direction may induce other engineers to take up the subject. Although much has been accomplished, he feels that the system can be still greatly developed in large works having capital and far greater facilities for experimental work at their command than are possessed by his Company.

Government Regulations Affecting Electric Power Distribution in England.[1]

Very early in the history of electric distribution the industry was put under the control of the Board of Trade, which was empowered to draw up and enforce rules regulating the mechanical and electrical features of the apparatus employed. It may be said generally that these rules were reasonable, and in the main have operated for the safety of the public, and to the advantage of undertakers. At times they have caused dissatisfaction to some ardent souls; but with a public so suspicious of novelties as the British, and so prone to panic without cause, it has been an advantage that almost every chance of accident has been guarded against, and that an excess of precaution has been enforced. Electric lighting and electric tramway plants are situated always in populous centers, and any accident happening in relation to their conductors is likely to endanger passers-by, who, as a rule, are devoid of even the most elementary knowledge of how to act, and often run into danger in seeking to avoid it. It was therefore quite justifiable to demand from the promoters of such undertakings a very considerable outlay to insure the public from all causes of alarm, and even from the possibility of creating dangers for themselves. But with the advent of the new power companies, several of which obtained Acts both in the sessions of 1900 and 1901, a new set of conditions has arisen, and some of the existing rules will need to be greatly modified if the new development of the electric industry is not to be strangled. The public has now had a 7 years' apprenticeship in relation to electricity, and may be supposed to have acquired some little knowledge of the subject, so that they do not require to be protected in the same way. They have passed out of the nursery—in which the fire is provided with a guard 3 feet high, to prevent heedless fingers being thrust between the bars—into the parlor, where the fender is little more than an ornament. It remains to be seen whether the Board of Trade will recognize the change, and will relax to some extent the conditions which have served their purpose, and are now becoming obsolete.

The power distribution companies, one of which is in operation, and others of which are full of preparations, can only succeed by working at high pressure, and by keeping down the cost of their mains as far as possible. It is the money sunk in conductors that threatens their financial position. A great deal of that must be laid down at once, and years in advance of the time when it can earn a substantial revenue. They cannot be always breaking the roads to lay fresh wires; for even if the expense were not prohibitive, the public would scarcely bear the proceeding with patience. Now it is just on the question of cables that the Board of Trade rules are most stringent. Overhead wires are practically prohibited, although nearly all the great power schemes of America and Switzerland have them. Underground cables must not transmit more than 1,000 kilowatts, and thus are restricted to small sizes, which are relatively exceedingly expensive. At the central station of the Manchester tramways this regulation has involved the use of quite an unnecessary number of cables, and, if it is not rescinded, will cause endless expense to the power companies. The thickness of the dielectric required by the Board is needlessly great. Our ideas on this subject have greatly changed during the past few months, and we are probably on the eve of great changes in the construction of cables; that is, if science is not hampered by absurd restrictions. In other countries pressures of 20,000 and 40,000 volts are used, but these are not at present possible here; it is only by the use of high pressures that the benefits of cheap power can be brought to the gates of works and shipyards.

In view of this state of affairs, the electrical trade section of the London Chamber of Commerce appointed a power mains regulations committee to consider what modifications are desirable in the existing Board of Trade rules and regulations affecting electric power supply and transmission. The committee consisted of nine members, Mr. R. Percy Sellon being in the chair, and they took pains to learn what were the regulations adopted in Switzerland, France, and the United States. In a report just issued the regulations in force in the several countries are given at length, and form very instructive reading. Generally speaking, they differ from those in this country in dealing rather with directions as to principles than with details. The rules in Switzerland are very lengthy, and have been drawn with a keen eye to the safety of the public. But, at the same time, they evidently recognize that the electrical distribution of power is a matter of great importance to the country, and is not to be unduly hampered. Every reasonable precaution is demanded; the overhead wires are to be of such a tensile strength, fixed at a certain height, with spans not exceeding a maximum amount, and so on. In populous places notices are to be affixed to the poles, stating that it is fatal to touch the wires. It is assumed that the passers-by will understand these, and will refrain from meddling with what does not concern him. If he does not, then he pays the penalty. The Swiss evidently recognize that it is quite as much the function of the Government to assist enterprise as to protect folly from itself.

In France and Germany the rules are shorter than in Switzerland, and generally less stringent; while in America there are practically none at all. There is, therefore, ample precedent for requiring that the severe regulations in this country should be relaxed, now that they have served their purpose. It is asked that a deputation may wait on Mr. A. P. Trotter, electrical adviser to the Board of Trade, to lay before him the conclusions of the Committee, which are printed below; and we hope that all who are interested in the success of the power companies—which means everyone who has the manufacturing interests of this country at heart—will exert themselves to bring pressure on this department to aid the Committee. The recommendations are quite moderate, and in the main are a plea against hard-and-fast regulations. It is desired that the swaddling clothes, with which the infant industry has been swathed, shall be relaxed, and that room shall be allowed for growth. Each scheme, according to the Committee, should be referred to the Board of Trade for criticism and approval; and if it bears evidence of careful design, and of solicitude for the safety of the public, it should not be rejected because it does not afford theoretical and absolute protection under all conceivable circumstances. If other departments of industry were subject to the same restrictions as electricity, the country would come to a standstill. We should have neither railways, steamships, nor machine tools. The man in the street must take some care of himself. He is credited with knowledge of statesmanship, economic science, and other abstruse subjects, and if he cannot learn to refrain from touching electric wires when mischance brings them within his reach, he must be a greatly overrated individual. A hundred

1. *Engineering.*

people are killed by paraffin lamps for every one who meets his death by electricity, and yet the Legislature will not raise the flash point of oil, dreading the outcry the action would raise. It only needs persistent pressure to bring the Board of Trade to a more raasonable frame of mind, and it is the business of our readers to add their share to this pressure.

ELECTRICAL POWER MAINS REGULATIONS COMMITTEE.

Memorandum for Inclosure to Mr. A. P. Trotter, Electrical Adviser to the Board of Trade.

1. *Voltage of Supply.*—Speaking generally, the Committee submits that the Board of Trade should be prepared to sanction distributing systems at voltages at least up to 20,000 volts between any two conductors, on the undertakers describing and adopting an approved method of working; and on the understanding that precautions are adopted similar to those which have been found successful in other countries. The Committee does not think that an arbitrary limit should be fixed even at 20,000 volts, as cases may arise where higher voltages are desirable; but, in such cases, admits that undertakers might reasonably be asked to specify in detail, for the approval of the Board, the character of the extra precautions they propose to adopt.

2. *Power Conveyed by Mains.*—The Committee considers that limitation of the size of mains, or the output which they may carry, is unnecessary and incompatible with natural development; though they think that the Board might reasonably require that undertakers should as far as possible arrange their system of mains to include an alternative route in case of accident. Where, however, more than 2,000 kilowatts is habitually to be transmitted by one main, the undertakers might be required to notify the same to the Board of Trade for the purpose of record; and the Committee would regard as reasonable a regulation to the effect that, after exceeding a capacity of 8,000 kilowatts, a central station should not transmit more than one-fourth of its total energy by one set of mains without notification to the Board of Trade; but that not more than two sets of mains should be required up to 4,000 kilowatts.

3. *Laying and Protecting of Cables.*—The Committee strongly urges on the Board of Trade that the regulations under this head should be open and elastic. Most of the power transmission work which has been done abroad has been carried out by means of overhead wires, and there do not exist at present such large and complicated horse power distributions as are contemplated in the power distributions in this country. There can be no doubt that the use of underground mains on a large scale will ultimately lead to great improvements, diminishing their cost and increasing their efficiency; and it would be highly undesirable that rigid regulations should be laid down before experience has been acquired, and thus stand in the way of legitimate experiment, development or invention, and place undertakers in this country at a disadvantage compared with undertakers abroad. Where the conductors are interwoven into a single cable, and where the neutral point of the system is earthed, the Committee submits that the use of a metal sheath in addition to the lead covering should be optional, provided suitable mechanical protection is afforded.

4. *Thickness of Dielectric in Cables.*—The Committee would point out that it can find no rule in any country abroad, or in America, making a particular thickness of dielectric compulsory. It submits that the present Board of Trade rule is not founded on any scientific basis, and since it was made, further advances have shown that great thickness of dielectric is sometimes actually a disadvantage. Abroad, makers after careful experiment have successfully adopted much thinner layers with advantage, while there is a great saving in cost. The Committee suggests that undertakers and cable makers should be left to settle this matter between themselves.

5. *Permission to Use Bare Overhead Conductors.*—The Committee would particularly point out the fact that the Board of Trade regulations have hitherto practically entirely prohibited overhead work in the United Kingdom, except under such onerous regulations as to make it impracticable. There are large areas in this country, and in the districts over which power supply bills have been granted, the character of which is similar to districts where bare overhead wires have been successfully and safely used on the Continent and in America, at very high voltages, for the past 10 years. The great development of power transmission on the Continent and in America has been largely by bare overhead wires, in a form which has been entirely prohibited in this country; and great industries have arisen, based on their use, which have no counterpart here at all. The Committee is strongly of opinion that permission to use overhead wires outside crowded city areas is vital to the commercial success of power schemes over large districts, and suggests that on this point the regulations should be brought into line with those current in other countries.

6. *Sub-Stations and Transformers on Consumers' Premises.*—The Committee considers that undertakers should be permitted to place transformers up to the voltages contemplated above on consumers' premises, in sub-stations above or below ground, provided they are properly designed, drained and ventilated; and that the amount of power to be installed in sub-stations should be left to the undertakers' discretion.

The Control of High-Potential Systems of Large Power.

[A paper read by MR. E. W. RICE, JR., at the Buffalo, N. Y., meeting of the Am. Inst. Elec. Engrs.]

The enormous increase in the use of electricity for lighting, traction and power has necessitated important changes in our generating stations. As the areas to be served have rapidly increased, corresponding increases have been made in the size of these stations and in the electrical potentials employed. The change has been due, not only to the great natural growth but to the consolidation of generating machinery into fewer stations. Instead of a number of separate stations, containing relatively small units producing electricity at comparatively low voltage with relatively large transmission losses, we now frequently find one large central station, containing generating units of great size delivering electricity at a high potential. Dynamos of 2,000 to 5,000 kilowatts capacity are displacing those of 200 to 500 kilowatts, and pressures of 5,000 to 15,000 volts those of 1,000 to 2,000 volts. The design and manufacture of large generating units of this character have called for engineering skill of a high order, and it can now be fairly claimed that the production of such machines has been reduced to an exact science.

The rapid evolution and present perfection in dynamo design have been due to the skill with which the various problems have been solved by the designing engineers and to the ease with which the data based upon machines of relatively small size were applied to those of larger size.

It is evident, however, that great advances in the capacity and voltage of generators would be useless, if not positively dangerous, unless adequate means for controlling and switching the electrical current were at hand. The evolution of the dynamo was for a time more rapid than that of the devices for controlling and switching currents of large volume and potential. As a result, a number of machines of large size were placed in operation with comparatively inadequate methods of switching and controlling. The energy and power which can be safely concentrated in a single central station are obviously limited by the amount of current and voltage which switching devices can safely handle. This fact was especially forced upon the attention of the writer at the time when the company with which he is connected took the contract for the equipment of the generating station of the Metropolitan Traction Company, of New York. This station was to contain 11 3-phase dynamos, each of 3,500 kilowatts output at 6,600 volts. In order to realize the full economy of such a station, it was, of course, necessary that all the generators should supply current to a common bus-bar, and that from these bus-bars the current should be distributed through feeders to a number of sub-stations. The sub-stations were to contain rotary converters, frequently working in multiple with large storage batteries on the direct-current side. The characteristics of such a load prevented any reliance being placed upon the opening of the exciting circuit of the generators in case of the necessity of a general shut down, as the rotary converters would, under certain conditions, supply sufficient magnetizing current to excite the generators, even with the field windings of the generators unexcited. It became, therefore, essential to produce a switching mechanism which would enable the generators to be connected and disconnected from the bus-bars with certainty and safety under all conditions of load, even up to a short circuit, and also that the various feeders supplying the sub-stations should be capable of the same treatment. Three types of switching devices were available for this work and were carefully considered:

1. Switches breaking the circuit in the open air.
2. Switches arranged to break the circuit in an inclosed air space.
3. Switches arranged to break the circuit under oil.

Switches of the first type (open air) were impraticable, because the space demanded to make such switches operative could not be provided.

Switches of the second type (inclosed air) had no such limitation, but oil break switches were found to meet the conditions more perfectly. Tests conducted showed that energy up to 2,000 to 3,000 kilowatts could

be controlled in a single oil switch at potentials as high as 15,000 volts, which was the limit of the apparatus at our disposal at the time. Switches of this type, however, as large as was considered necessary, required an amount of oil per switch so great as to be objectionable, in view of the large number of switches required for generators and feeders. The problem then was to produce a switch which would retain all the advantages of the usual oil switch and at the same time minimize the quantity of oil.

The type which was finally evolved and employed in the Metropolitan installation has shown itself in practice to be remarkably successful. It is known as the Form "H" Oil Switch by the manufacturers, and was designed by the writer, with the assistance of Mr. E. M. Hewlett. It was described by Mr. J. E. Woodbridge in the *Electrical World and Engineer* of April 14, 1900. Reference to this article will give the details, which I need not here repeat. I shall simply outline the principal features.

The switch, as designed for 3-phase circuits, consists of three double pole, single phase switches or elements. Each single phase switch is contained in a fireproof cell, but all three switches are designed to be operated simultaneously. Each single phase element consists of two brass cylinders or cans, one can for each pole. The incoming lead is attached to one of the cans and the outgoing lead of the same phase to the other

Each cylinder is nearly filled with oil and is covered by a metal cap which carries a long insulating sleeve. Two copper rods joined by a metallic cross-head and forming together a U-shaped conductor, slide through the insulating sleeve and fit into tubular contacts at the bottom of the cans when closing the circuit. The cross-head of each U-shaped conductor is attached to a wooden rod, which extends through the top of the cell or casing which incloses the switch, and is in turn attached to a metal cross-head operated by an air motor or an electric motor, as the case may be.

The 3-phases are seen, therefore, to be broken or close simultaneously. When the three sets of U-shaped conductors are lifted, the circuit is broken under the oil at two points in each phase, or 6 points in each complete 3-phase switch. The range or movement of the cross-head varies with the potential to be controlled; it is 12 inches in the switches in the Metropolitan station for 6,000 volts, and 17 inches in the switches for the Manhattan station for 12,000 volts. The brass cans are lined internally with fiber to prevent the arc from jumping from the rod to the metal of the can when it is drawn up through the oil. Each switch unit stands alone on its own foundation, with the 3 phases in 3 separate cells or spaces separated by brick walls. These brick partitions act as barriers and prevent any possible burn-out in one cell from spreading to the others.

As an opening of two legs breaks a 3-phase line, an arc in one cell will not incapacitate the switch. The circuit breaker or switch differs radically from older forms in the separation of the phases as indicated, and also in the separation of the contacts for each phase, in two separate oil pots. This separation of the terminals of each phase gives two separate arcs, each inclosed in a space well removed from the others, so that the possibility of an arc communicating from one pole to another is obviated. It will be seen that in breaking a 3-phase circuit, the arc is produced in 6 independent oil pots. This method of construction, together with the separation of the phases in separate fireproof compartments, accounts for the unusual effectiveness of the switch in practical operation. The general construction of the switch is clearly shown in the accompanying illustration.

Fig. 1 shows the switch used in the installation of the Metropolitan Traction Company, New York. It is designed for 6,600 volts and 300 to 800 amperes.

Fig. 2 shows the same switch as modified to suit the conditions of the Manhattan electric installation. On account of the higher voltage the oil pots are larger and a larger opening of the circuit is provided. The 12 covers for the oil pots are replaced by porcelain. It is designed for 12,000 volts and 300-800 amperes.

Fig. 3 illustrates the inclosed air tube type of switch already mentioned. This switch has given most excellent results on high potential work.

Fig. 4 shows a form of tank oil switch, without the tank for containing oil.

Fig. 5 is a reproduction from a photo taken at Kalamazoo of a special form of open air switch. The switch was opening a circuit of 25,000 volts and 60 amperes at the time when the photograph was taken.

It was at first thought that the use of oil switches for the control of high potential circuits would possibly result in resonance effects, particularly in circuits containing considerable capacity, such as underground cables or long overhead lines. A number of experiments have been conducted and the weight of evidence seems to be in favor of the oil switch as avoiding these effects. It has been found as an interesting fact that under the conditions described considerable disturbance due to resonance may occur upon the *closing* of a circuit. This is naturally independent of the character of the switch employed; it may occur equally well with an oil, an inclosed air, or an open air switch.

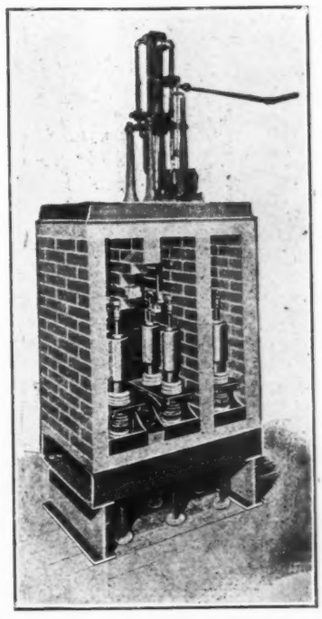


Fig. 1.—Pneumatically Operated Switch.

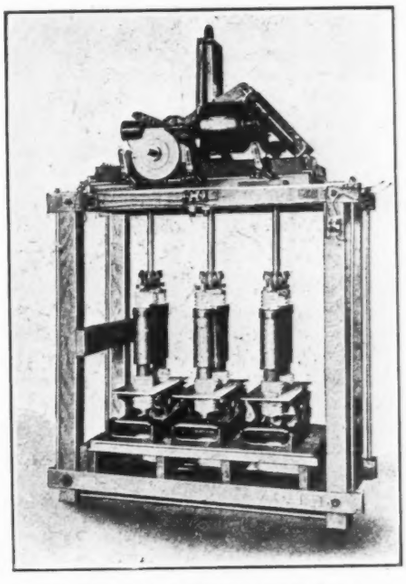


Fig 2.—Electrically Operated Switch.

Upon the rupture of the circuit, however, the results obtained from many tests indicate that open air switches are liable to produce heavy resonance effects, while the inclosed air and the oil switch are practically free from such effects. Extensive experiments to determine this point were conducted prior to the production of the switches for the Metropolitan and Manhattan stations. Very recently experiments of a more severe character have been conducted at Kalamazoo, Mich. These tests were made at from 25,000 to 40,000 volts, with from 1,200 to 1,300 k.v.a. of highly inductive load, the power factor being 40 to 60 per cent. The switches tested were the cylindrical oil switch, already described (Metropolitan type); an oil switch in which all the terminals were inclosed in a single tank of oil, called the tank oil switch; a switch of the expulsion air tube type; and an open air switch in which the terminals were simply separated long distances in free air. In making these tests an

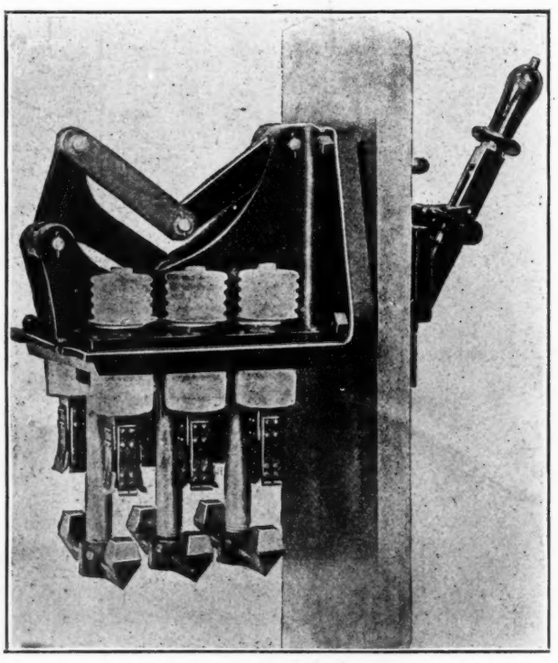


Fig. 3.—Oil Break Switch.

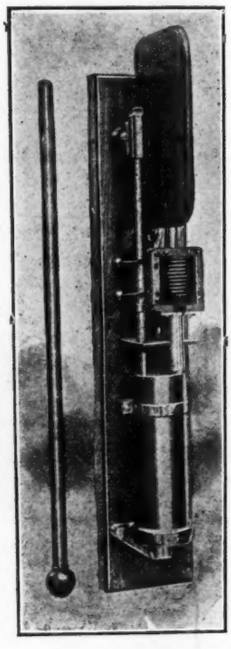


Fig. 4.—Expulsion Type Switch.

oscillograph was used to determine the time of break and other interesting effects, and a camera to photograph any particularly instructive phenomena.

The long break open air switch, which operates upon the principle of drawing a long arc in the open air, opened the circuit at 25,000 volts, but required several seconds of time and drew such a long arc as to be impracticable. At 40,000 volts the arc held and flared to a total distance of over 30 feet until it struck the line and short circuited the system, producing at the same time high voltage oscillations equal to two or three times the normal potential of the system. It would, therefore, seem that the open air switch was generally unsuitable for the control of high voltage systems of large power, as even where sufficient room is available for their use, the production of high resonance effects tends to endanger the system. These tests also show that wherever a short circuiting arc occurred in the open air, electric oscillations of high voltage resulted. These were probably due to the rapid alternate extinguish-

Fig. 5.—Experiment with Air Break Switch at Kalamazoo.

ment and formation of the arc during its period of interruption, the arc acting somewhat in the manner of a Wehnelt interrupting device. The dangerous character of short circuiting arcs emphasizes the need of the precautions which I shall mention in this paper, having in mind the avoidance, as far as possible, of such accidental short circuits.

The expulsion tube air switch operated up to 25,000 volts, but failed at 40,000.

The tank oil switch operated satisfactorily on 1,200 to 1,300 k.v.a. up to 25,000 volts, but at 40,000 volts it spat fire and occasionally emitted black smoke, thus seeming to be working at the limit of its capacity. No attempt was made to open short circuits with the tank oil switch.

The cellular oil switch never failed to open 1,200 to 1,300 k.v.a. at any voltage up to the maximum employed, 40,000; the circuit opening noiselessly and without the appearance of fire or emission of smoke at the switch. It was used as an emergency switch in all the tests to open short circuits on 25,000 to 40,000 volts. The results of these and other tests, and the continued effective operation of the cellular type switch in the Metropolitan station indicate that this type of oil switch will safely control circuits of practically unlimited power at potentials considerably above 40,000 volts, probably as high as 100,000 volts.

The character of the break when operating properly was the same in all the switches except the open air type. In opening, the arc held for a number of half waves from 6 to 18 and then broke at zero value without disturbance of the system. With the oil switches no traces of oscillation were noticed before the break, and no traces of rise of voltage. With the expulsion air switch, traces of oscillation were seen for a number of half waves before the final break, and in consequence a slight voltage rise occurred.

I will not attempt to describe the numerous observations made at the Kalamazoo tests, as these will undoubtedly be given to you by our president, who supervised these tests and to whom I am indebted for the information which I have given regarding them.

In addition, however, to the production and use of a switch which will be as safe and reliable as engineering skill can make it, there are certain other factors which should be considered in connection with the control of current for high potential stations which should be taken into consideration by the electrical engineer. It should be constantly kept in mind that no apparatus can be absolutely free from accident, no matter how carefully designs are constructed. The engineer should, therefore, carefully consider the possible effect of any accident with particular reference to the possibility of an accident to one element involving other apparatus. The layout should be such that an accident to one element could not of itself, or in consequence of a chain of accidents, result in a breakdown of the entire generating station, even for a short time.

The mechanical engineer has considered this point and met it with a fair degree of success in the large modern central station with the fireproof boiler house and the frequent sub-division of this boiler house into two or more portions by suitable fire walls, as in the case of those of more than one story.

The general employment of a duplicate system of steam piping, or its equivalent, also provides a reasonable safeguard against failure of supply from accidental disarrangement of a steam system. The steam engines in well arranged stations, being important units, are placed a sufficient distance apart, and so disposed, generally, that an accident to one will not easily involve other units. This is also true of the dynamos which are directly coupled to the engines.

The switchboard with its switches for controlling and appliances for measuring the output of the generating station, the cables leading from the generator to the switchboard, the location of the bus-bars, and the disposition and arrangement of the feeder cables for distributing the current, have not, as a rule, been given that serious attention which their importance deserves; in fact, the consideration of the electrical controlling devices and the wiring of the station has been apparently left to the last, and it is frequently the case that a generating station containing apparatus of great value has been jeopardized by the lack of careful design of the switching appliances. Stations designed to deliver a normal output of from 5,000 to 10,000 kilowatts, at relatively high pressure, say, 5,000 volts or upwards, frequently contain switches for controlling the generators and the feeders mounted upon the face of a long continuous panel, and so crowded together that in case of failure to open the circuits the resulting arc would be almost certain to involve adjacent switches and even possibly cripple the station for a time. The bus-bars are also often so disposed that an arc may easily start thereat or at least so that an arc, if started for any cause, would be liable to seriously damage the switchboard.

The same methods frequently obtain in regard to the manner of installing the conductors; high tension and low tension conductors being often mixed together and the conductors so arranged that in case of any injury to one, others of the conductors leading from the generators or from the switchboard out of the station are in danger of being involved.

These methods have probably arisen from the fact that up to a comparatively recent period the service of a city for lighting and for power has been separated among a number of different stations, each of a relatively limited amount of power. In case of the failure of any individual unit in such case, as of the generator, switchboard, or other apparatus, the damage was small, owing to the limited energy available. A shut down, even of the whole station, was comparatively unimportant. However, the case is quite different with the large modern station with output of from 10,000 to 100,000-horse power, which is designed to supply electrical energy for a large portion of a city's needs, combining frequently electric power for traction purposes, for lighting, etc. The economies expected of such stations – lower cost of operation, smaller investment and greater economy in coal and in steam – due to the better load curve obtained by the concentration of loads of large area and of various character in one station, as well as to the higher efficiency of the large units, are familiar to all electrical engineers. I am inclined to think, however, that the possible dangers of such a concentration of energy have not been fully realized. The failure of such a station, even for a brief period, would be a disaster which, with proper design, need not occur.

I will briefly outline the principles which I believe should govern in the layout of such a central station, the details of which may naturally be varied considerably to suit local conditions. It should be kept in mind that I am discussing stations of normally large output, say, 5,000 kilowatts and over, although many of the principles mentioned could probably be applied with advantage to stations of smaller size. Broadly speaking, I would carry the principle of subdivision into units as far as practicable; the units to be chosen with respect to the size of the station, character of load curve, etc. The boiler house, as already stated, should be sub-divided into two or more distinct portions, so that injury to one will not involve the entire steam system. Fortunately, the foundations, masonry and mounting of boilers are so essential and of such a nature that damage to one unit is not liable to involve another. At the same time, it is important that the boiler house should be divided into two or three sections, separated from each other by brick partitions. The steam piping should be in duplicate or a substantial equivalent, and so arranged that the bursting of a steam main cannot flood all the boiler rooms with steam or stop the entire flow of steam to the engine room. The engines, with the dynamos coupled thereto, may be placed in one large room, provided this room is of sufficient size to enable the units to be placed at proper distances apart. The switchboard should preferably be placed in a separate room, so that any accident to the engine or to the steam piping will not injure the switchboard operator or the switchboard mechanism. The electrical conductors from each dynamo should be led to the switchboard as far apart as possible from those of other units. Each set of conductors should be led to its own switch. Each switch should be of ample capacity to interrupt the entire output of the generator at full voltage and even take care of the concentration of the entire load of the station, as in a short circuit. This switch should be placed in a cell of fireproof material and preferably electrically controlled from a central point. If so disposed, these switches may be placed reasonably close together, but the partitions should be such that any one of the switches could arc to destruction without involving the switch of a neighboring generator. Switches should be in duplicate, so that in case of failure of one, another switch will be in readiness. Especial care should be taken, in leading the conductors from the switches to the bus-bar, to keep the conductors as far as possible from those of neighboring units.

The bus-bar or bars should preferably be in duplicate, or some equivalent arrangement such as sectional sub-division, should be adopted. Bus-bars should be carefully protected in fireproof compartments so arranged that it would be impossible for any arc to short circuit from one conductor to another or for it to be injured by an arc caused by the destruction of any of the generator or feeder switches. The same care should be taken to isolate the conductors leading from the bus-bars to the feeder switches. The feeder switches should also be in duplicate; that is, two separate sets of switches on each feeder in series with each other when feasible, or the conductors leading to a group of feeders may be joined together by a switch placed in series therewith controlling a group of feeders. Each group switch and each of the feeder switches should be mounted in its own separate fireproof compartment and preferably controlled electro-magnetically from a distance. The conductors leading from the feeders out of the station should not be massed together in one conducting trench or well, but should be subdivided into as many groups as circumstances will permit.

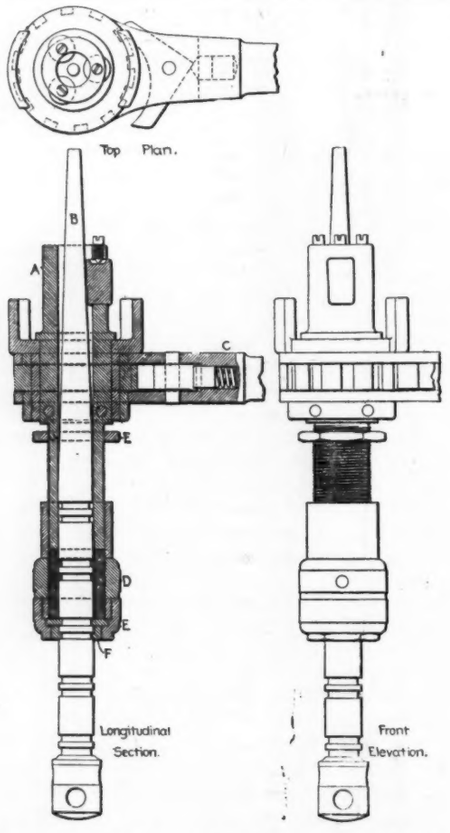
The constant aim throughout the entire station should be to limit the normal flow of energy in a given space to a predetermined amount, preferably for example, to that of the generator unit which has been selected, or in the case of the feeders leading outside the station the normal flow of a group may be limited to that delivered to any one substation.

It is obvious that the arrangement of switchboard, as described, will occupy more space than the ordinary panel type. The total space occupied, however, is but a small portion of the total space required for the generating plant, and it is believed that the precautions recommended are essential to the continued success and reliability of large generating plants. Such separation of the switches, etc., makes some method of control from a distance very desirable. The motors used for operating the switches may be either pneumatic or electric. The control of these motors should preferably be electric in all cases. By adopting electric control from a distance, it is possibte to combine all the switches required for the generator, feeders, etc., upon a small keyboard under the observation and control of a single operator. It is also possible to place this operator in such a position that he will have a comprehensive survey of all the measuring and controlling devices needed for the station, and at the same time be free from danger in case any of the apparatus should fail to perform its work. Under such circumstances the operator is much less liable to make a mistake, and it is believed that having taken such precautions accidents even of a trivial character will be more unlikely to occur. In laying out the electrical devices for such a station the utmost simplicity should be aimed at; not a single instrument, conductor or switch being placed in the station that has not been carefully considered and felt to be essential. It is better to err on the side of simplicity than of complexity.

A Good Tube Expander.

Messrs. the Watson-Stillman Company, of New York, are putting upon the market a device for the expanding of tubes that seems to have much merit. The illustration shows clearly the nature of the device. Three rollers are held loosely by set screws in the casing (*A*). Instead of revolving the taper pin (*B*) and feeding it by continued hammering upon the head, the entire roller case is revolved by means of the ratchet lever (*C*).

Applying the power to the case instead of to the pin is said to increase the speed of the work, and also to facilitate rolling imperfect tube surfaces, such as lumpy welds, etc. The taper pin is fed by means of the screw-feed nut (*D*), thus avoiding all hammering upon the pin. At the bottom of the feed nut, a thin hexagon nut (*E*) is shown which acts as a depth gauge. By removing the upper cap (*E*) of the feed nut the split interlocking ring (*F*) may be shifted from one double slot to another upon the taper pin, thus making it possible to roll tubes vary-



ing in diameter from 2¾ to 3¼ inches. The rollers are made with the proper taper to bring their surfaces parallel with the interior surface of the tube.

The Development of Bituminous Pavements.

[From a paper read before the League of American Municipalities by Mr. Fred. J. Warren, Boston.]

All forms of bituminous pavements, whether manufactured from natural or artificial asphalt, are in fact artificial stone pavements. The industry started with the use of the natural rock asphalt from the mines in the Val de Travers, Canton Neufchatel, Switzerland. The mines were discovered in 1721, but it was in 1849 that its utility as a road covering was first noticed. The rock was then being mined for the purpose of extracting the bitumen contained in it for its use in medicine and the arts. It is a limestone found impregnated with bitumen, of which it yields on analysis from 8 to 14 per cent.

It was observed that pieces of rock which fell from a wagon were crushed by the wheels, and under the combined influence of the traffic and heat of the sun a good road surface was produced. A macadam road of asphalt rock was then made which gave very good results, and finally, in 1854, a portion of the Rue Bergere in Paris was laid with compressed asphalt on a concrete foundation. In 1858 a still larger sample was laid, and from that time it has been laid year by year in Paris. From Paris it extended to London, being laid on Threadneedle street in 1869, and Cheapside in 1870, and in successive years on other streets. It has also been extensively used in Berlin and other cities on the Continent.

The early success of the asphalt pavement in European cities led American contractors to seek the manufacture of an artificial asphalt which would have similar qualities, and the first idea was to utilize the tar produced at the gas works, which was then almost without value. The result was about 12 to 15 compounds, varying only in detail, being all essentially composed of tar, or coal tar pitch and sand, forming an artificial sandstone. Large quantities of these pavements were laid in Washington and other cities between 1870 and 1874, the stone pavements on Fifth avenue, New York city, being surfaced in this manner. A large number of cities, especially in New England, use this artificial mixture successfully on sidewalks, and the coal tar sidewalk continues to be in greater use in Massachusetts than all other forms combined.

The result on street work was a general failure, and the impression has since generally prevailed that coal tar or its products is entirely unsuitable for roadway construction. The work was done at ridiculously low prices by contractors who had no previous familiarity with the construction of bituminous pavements or incentive to improve, and, in fact, at the time the pavements were laid, no one in this country or Europe had any accurate knowledge of the requirements necessary to produce good work. A few of these pavements, however, are in use to-day even on roadways, and have been in use longer than any asphalt pavements in existence in this country or in Europe. I think all failures can be traced to the use of inferior grades of coal tar, improper methods of preparing the cement, and the use of improper sand in the wrong proportions.

The early failure of the artificial asphalt pavements put them almost entirely out of use in roadway construction. A German chemist, Prof. de Smedt, had secured a patent on a formula for making a bituminous surface, using natural asphalt as a cementing material. Experiments were made with Mexican, Cuban and Trinidad asphalt; the so-called Albertite, Gilsonite and other bitumens found in this country were also tried, but generally without success. Small samples of the Trinidad Lake asphalt pavements were laid in Newark, N. J., and in New York city, in 1870 and 1871, respectively, but it was not until 1876 that a pavement was laid on a large scale.

Chemists generally knew that there were physical properties in asphalt which made it impossible for them, by any chemical test, to determine the durability or utility of any given asphalt, and no city could be induced to adopt this form of pavement until, from actual test, it had stood in Fifth avenue in New York, with an average daily traffic of 13,000 vehicles, for several years.

In 1876 Pennsylvania avenue, in Washington, was in an almost impassable condition, being covered with a rotten wooden pavement. Congress directed its repaving, and appointed a commission consisting of Gen. H. C. Wright and Gen. Q. A. Gillmore, of the Corps of Engineers, and Edward Clark, architect, to have supervision of the work. The terms of the law directed them to lay the best known pavements. They advertised for proposals, making no restrictions as to materials. They received 41 proposals, for every variety of stone, wood, macadam and bituminous pavements. Out of them all the commission selected two, and laid these respectively on two-fifths and three-fifths of the avenue. These were the natural rock asphalt from Neufchatel, and the Trinidad Lake asphalt mixture. Both pavements were completed in the spring of 1877. The Neufchatel pavement lasted about 10 years, while the Trinidad Lake mixture was not re-surfaced until 1890.

After 1876, under the present permanent form of government, the asphalt pavement has become the recognized pavement of Washington. It has spread from Washington to many other American cities, Buffalo taking the lead, with something over 300 linear miles, Philadelphia and New York city also laying large quantities each year.

Many other forms of asphalt have from time to time come on the market, and have been laid with more or less success. The physical differences which existed in the new varieties of asphalt have made it necessary for their promoters to develop new formulæ, and to endure many poor pavements laid during experimental stages and under close competition.

It seems to be a fact that the early asphalt pavements caused as much annoyance to the promoters as did the early coal tar pavements, but they were generally laid at a good margin of profit, under a guarantee system which justified and encouraged the most careful methods and immediate repair of defects; and considering the complications presented in the manufacture of the bituminous surface, it is to the credit of the established paving companies that they have succeeded in laying asphalt pavements so satisfactorily.

As late as 1885 some of the pavements laid by the most experienced companies were complete failures when first laid, and the cost of repairs during the first 5 years sometimes amounted to twice the original cost of construction of the wearing surface, while the average cost of the most experienced companies for the maintenance of pavements laid since 1890 will hardly average 5 per cent. of first cost of surface during the first 5 years, and the pavements are frequently in perfect condition without repair at the end of that period. When it is considered that a slight variation from the proper proportions of ingredients brings about disastrous consequences, the improvements are quite remarkable.

Probably the greatest failures were due to improper selection of the sand or mineral grain. Sands which careful analysis show to be very different are frequently so closely alike in appearance that the most expert eye could not detect the difference. There was no record kept of the nature of the sand until recent years, almost any sand being considered suitable.

The bitumen is used to surround the grains of mineral matter for the purpose of cementing them together. In the Richardson patent formula, used in the Trinidad Lake pavement, the mineral grain is so fine that the aggregate surfaces of the grains to be coated approximate 1,000 square inches to each cubic inch of the wearing surface, and the coating of bitumen around each grain is about one four-thousandth of an inch in thickness.

If the sand is not of such graded sizes that the voids are not approximately filled by the bitumen used, then on exposure in such minute particles early failure is quite certain, on account of evaporation and decomposition. A slight variation in the size of the grains makes a great difference in the area of grains to be coated with bitumen, and in turn, in the thickness of the coating when a given proportion of bitumen is used, and consequently upon the length of time which it would take to change its physical condition on exposure. So great is the difference that a given bulk of sand, of an even size, passing a No. 200 screen, contains about 30 times as much surface to be coated as does the same bulk standing between a No. 10 and No. 20 screen; and about 1,000 times as much surface to be coated as does the same size of grain passing a 2-inch screen and standing on a 1-inch screen. In the effort to duplicate the Neufchatel pavement, the entire development and practice has been to exclude from the bituminous mixture all mineral grains coarser than about $\frac{1}{8}$ inch in diameter.

A form of bituminous roadway known as tar macadam has been used in England with variable results for more than 30 years, and also in a few American cities. The process employed is defective in principle and does not accomplish uniformity. I feel that there is little permanent merit in the use of crude tar, or in coating stones of even sizes laid in courses, with an effort to roll the several courses together, as the very life of the bitumen depends upon its proper selection, preparation and use, in proper proportions, with a dense mineral mixture.

Considerable investigation has convinced me that both practices are wrong, and that the future development of bituminous pavements will be along the line of using a coarser mineral aggregate than is used in the asphalt pavement, and more modern methods than employed in tar macadam.

The advantages of a coarse grain are: First, the coarse grain gives rigidity in itself not acquired by fine grains, and also gives a surface that will not wear slippery. Second, it is, therefore, possible to use a softer cement, which will have longer life. Third, a heavier coating will be secured around each grain, which will tend to increase the life of the bitumen if exposed. Fourth, the voids can be greatly reduced, thereby avoiding exposure of bitumen in minute particles. Fifth, lower temperatures can be used in mixing, and consequent saving in fuel and labor. Sixth, less danger of injuring the bitumen by overheating in the process of making cement or mastic.

The mixture to be used in any particular piece of work should always be determined by experts who will recognize the conditions present, and the special treatment necessary, as the complications are many. Under proper instruction failures should be reduced to a minimum.

A pavement constructed on above principles would be a bituminous concrete pavement, as distinguished from the bituminous mortar surface of the asphalt pavement.

Owing to the nature of the mixture, I think the best forms of coal tar, properly treated, will furnish the best form of bituminous cement for such a pavement. The coarse stone used should be the hardest procurable, and I can see no reason why, under proper development, the bituminous cement will not bind the mineral matter together until the stone itself wears out, under moderate traffic. I should not advise placing such a pavement on the heaviest traveled streets of large cities at the start. It would be best to develop perfection under more moderate usage.

I think the term bituminous macadam is a suitable name for such a pavement, as it contains all of the good points of a first-class macadam road with durability and cleanliness added; and, owing to the coarse grain, it is not as slippery as other forms of bituminous pavements.

An equipment of $3,000 to $4,000 in machinery would be sufficient to lay 300 to 1,000 square yards per day of bituminous macadam, and municipalities, under proper supervision, could do the work themselves much cheaper than by contract. The largest sample of pavement laid on this plan is in the city of New Bedford, Mass. Lowell, Mass., has also borrowed a plant to construct 5,000 yards or more, and Holyoke, Mass, has tried a block and seems well pleased.

The city of Pawtucket, R. I., was the first Eastern city in recent years to try the use of tar on its streets, doing the work itself under an old formula, but has recently had a sample of bituminous macadam laid on the above plan. Mr. Carpenter, the city engineer, was not satisfied with the lack of life of his first work, but he accomplished better results than others who have experimented on their own account.

The Economic Value of the Clarion Coal in Vinton and Jackson Counties, Ohio.

[From a paper by Mr. N. W. Lord, read at the last meeting of the Ohio Institute of Mining Engineers.]

The work described in this paper was done in connection with the Ohio Geological Survey, and with the co-operation of Prof. Edward Orton, Jr., the State Geologist. It is planned to continue the investigation of the less known Ohio coal seams, so that their economic value may be tested and published.

The Clarion coals of Pennsylvania, or rather the two seams, the Upper and the Lower Clarion, sometimes called the scrub-grass and Clarion seams, extend pretty near through the area of the coal measures of Ohio, but throughout the greater part of the State the seams have but little economic value, and, excepting possibly in some parts of Mahoning county, are not of much importance in the Northern and Eastern parts of the field. However, in Jackson and Vinton counties the seam develops into one of considerable thickness, and covers a large portion of the coal area of these 2 counties, where it is known locally as the Limestone coal, and sometimes as Coal No. 4, or 4A. It is opened in a number of places, mostly in local country banks or railroad mines.

The samples on which the present work was based were taken by Professor Orton last summer during a trip through the field. They were secured at points distributed carefully over the field so as to include the whole area known to contain the seam in considerable thickness.

Of the samples all but 3, 4 and 7 are from railway mines. No. 7 is a country coal bank supplying wagon trade, and Nos. 3 and 4 are openings, 50 to 75 feet under the hill. All afforded good sections of the coal. The samples were taken by "channeling" the vein from the roof to the floor, rejecting partings only. They were broken up, mixed, and quartered, and sent to the laboratory in sacks. Each sample weighed from 100 to 150 pounds.

The accompanying table gives the results of the work done on these samples in the metallurgical laboratory of the Ohio State University. I wish to acknowledge the assistance I received from Mr. E. E. Somermier, instructor in metallurgy, who carried out the details of this analytical and calorimetric work.

The proximate analyses were made by the method used in the former work of the Ohio Geological Survey, and published in Vol. 5, Ohio Geological Survey Reports. The ultimate analyses were made by the ordinary combustion method. The ash is that left after burning, and is not corrected for oxygen replacing sulphur. The oxygen is determined by difference, using the ash thus determined. The nitrogen was determined by the Kjeldahl process and sulphur by the Eschka method. The calorimeter determinations were made in the Mahler bomb and the results corrected for the sulphur burned to sulphuric acid, deducting 12 calories for each 1 per cent. of sulphur present. This figure represents the error due to calling the acidity in the bomb liquor nitric acid, when it is largely sulphuric acid, it leaves the heat due to the combustion of the sulphur to SO_2 intact. The reason why the ash in the ultimate analysis was not corrected for sulphur was the uncertainty as to the mode of combination of the sulphur, as will appear in the sequel. The tables show this coal to be high in sulphur, but of satisfactory character as to moisture and ash. The sulphur is noticeably irregular in the seam, varying from 2.87 per cent. to 6.14 per cent. The analyses, of course, represent "run of mine" and not selected coal.

Laboratory tests showed very little coking power in the coal.

Considering the ultimate analyses, the variations in the carbon, hydrogen and oxygen correspond closely to the variations in the amount of inert material. So that, taking the individual analyses, they show this fact, which has been frequently established in other coal veins of the State, viz.: That the ultimate composition of a coal seam (that is, its hydrogen, carbon, sulphur, nitrogen and oxygen) remains practically constant over considerable areas of the field. So, if we regard the seam as a mixture of coal, pyrites and ash, the coal part of the mixture is practically the same thing throughout a large area of the field. It is, therefore, possible to examine the coal part separately and determine its value as a heating material, and discuss separately the admixed impurities. The heating value corresponds very closely to that calculated by Dulong's formula from the ultimate analyses.

Dulong's formula as used = $8{,}080\ C + 34{,}460\ (H - \frac{1}{8}\ O) + 2{,}250\ S$.

The average heating value of the combustible is $8{,}187 = H$.

Table Showing the Results of Calorimeter Tests of Clarion Coal in Jackson and Vinton Counties, Ohio.

Sample No.	Location of Mine.	Carbon.	Hydrogen.	Oxygen.	Nitrogen.	Sulphur.	Ash.	Moisture.	Volume Combustible.	Fixed Carbon.	Calorimeter Results.	Calorific Power Calculated. From Ultimate	Calorific Power Calculated. From "H."
1	Sec. No. 34, Vinton township, Vinton county, O.	68.52	5.49	13.69	1.28	2.87	8 15	5.02	40.31	46.51	6,927	6,903	6,947
2	" " 35, Milton township, Jackson county, O.	67.30	5.47	14.16	1.28	3.70	8.09	5.61	38.92	47.38	6,821	6,794	6,854
3	" " 13, " " " " " "	66.14	5.39	13.31	1.28	4.08	9.80	4.98	39.71	45.51	6,752	6,720	6,743
4	" " 36, " " " " " "	67.51	5.44	13.45	1.26	3.73	8 61	4.71	40.51	46.17	6,867	6,834	6,883
5	" " 33, Vinton township, Vinton county, O.	64.91	5.36	12.05	1.30	5.28	11.10	4.61	41.35	42.94	6,696	6,694	6,594
6	" " 24, Wilkesville township, Vinton county, O.	65.04	5.36	12.95	1.28	4.16	11 21	4.72	39.88	44.19	6,694	6,637	6,681
7	Wellston, Jackson county, O.	66.52	5.50	14.58	1.28	3.72	8 40	5.33	41.01	45.26	6,781	6,726	6,850
8	Minerton, Vinton county, O.	67.17	5.44	13.03	1.28	4.23	8 85	4.52	40.10	46.53	6,854	6,834	6,849
9	Sec. No. 32, Bloomfield township, Jackson county, O.	62.05	4.98	12.12	1.23	6.08	13 54	5.31	37.33	43.82	6,321	6,346	6,291
10	" " 32, Madison township, Jackson county, O.	62.57	4.89	11.47	1.23	6.14	13.70	4.90	35.75	45.65	6,386	6,386	6,307
18	" " 5, Bloom township, Scioto county, O.	65.30	5.33	15.35	1.23	3.45	9.34	6.80	37.92	45.94	6,535	4,528	6,669
	Average	65.73	5.33	13.29	1.27	4.31	10.07	5.14	39.35	45.45	6,694	6,673	6,694

$$\left\{ H = \frac{\text{Average calorimeter} - \text{average } 8 + 2{,}250}{1 - (\text{ave. ash} + \text{ave. } S + \text{ave. moisture}).} \right\}$$

This is compared in the following table, with the corresponding value of H, for other well-known coals:

	Coal			
	Pittsburg.	Hocking.	Wellston.	Clarion.
Average heat power	7,532	6,663	6,953	6,694
Value of "H"	8,435	7,925	7,929	8,187
Calculated evaporation*	9.8	8.6	9.3	8.9

*In pounds.

The heating value of the individual samples calculated from this average value of the combustible, shows a satisfactory correspondence, confirming the writer's previous experience that the character of the coal as shown by its heating power is practically the same over considerable areas of a given seam. Nos. 10 and 18, which depart most widely from the rule, are both in outlying parts of the field. No. 10 on the extreme west, and No. 18 on the south.

To investigate the mode of occurrence of the sulphur in the coal samples Nos. 1 and 10 were taken as representing the highest and lowest percentages. In each of these samples the iron and the ash were carefully determined. This iron was then calculated as existing in the coal as pyrites and the sulphur necessary for this combination estimated as present in this form. In No. 1 the percentage of iron in the ash was 13.4 per cent.; iron in the coal 1.03 per cent.; sulphur combined with iron in the coal as pyrites, 1.18 per cent. Subtracting this from the total sulphur, 2.87 per cent., we find in that coal 1.69 per cent. of sulphur not as pyrites.

In sample No. 10, containing 6.14 per cent. sulphur, the iron in the ash amounted to 30.10 per cent.; iron in the coal, 4.12 per cent.; sulphur as pyrites, 4.71 per cent.; sulphur not combined with iron, 1.43 per cent.; showing a residual of sulphur in this case only a little less than in the other. In other words, the variation in sulphur is due to the pyrites and not to variation of the organic sulphur in the coal, this figure being practically the same in the two cases.

In order to test this a little further, sample No. 3, containing 3.70 per cent. sulphur, and No. 10, containing 6.14 per cent. sulphur, were crushed until they would go through a ¼-inch mesh and then washed. We washed it by hand in a miner's pan. We have found by numerous experiments that coal-washing by hand can be conducted so as fairly to represent that done on a large scale. We found in No. 3 sulphur in the washed coal, 3.08 per cent.; ash, 6.40 per cent.; moisture, 3.85 per cent. In No. 10, we found sulphur in the washed coal, 3.72 per cent.; ash, 8.70 per cent.; moisture, 4 per cent. In other words, the sulphur brought down by washing was very small in No. 2, but large in No. 10, where there was a large per cent. of sulphur as pyrites, the reduction being in this case nearly 50 per cent.

These experiments show that of the sulphur about 1.5 or 1.6 per cent. is "organic sulphur," the rest being in the form of pyrites, and varying locally in the coal, that washing might be expected to reduce the total sulphur to a uniform figure in the neighborhood of 3 per cent. The steam-raising power, or the relative evaporating power, may be calculated by the formula published by the writer in the *Engineering News* of Feb. 16, 1899. I have given this value in the foregoing tables for comparison with its value for the other coals.

Summing up the results of our tests, I may say the Clarion coal in Vinton and Jackson counties has a steam-raising value intermediate between Hocking and Wellston coal; that it is locally highiy contaminated with iron pyrites, but areas exist in which the pyrites is not very large in amount, but the total sulphur of the coal, of which possibly one-half would be organic sulphur, and therefore not represented by iron, will in few cases go much below 3 per cent., but with careful selection should be mined between 3 and 4, with pyrites contents equivalent to 1½ to 2¼ per cent. of sulphur. The amount of pyrites shou'd not, therefore, be large enough in carefully selected coal to be seriously detrimental in a steam fuel.

Economy in Pumps.

Mr. D. B. Dixon says that when Henry R. Worthington invented the steam pump many years ago, the most common type of pump then in use in mills and factories was the single acting, lifting and force pump. This pump drew water by suction at one stroke, and discharged it at the next, hence its name. It was driven by belt, sometimes by gearing, but for the most part by a combination of bell cranks and wrought iron rods driven from the main engine, particularly in distilleries and works located on the banks of rivers and creeks. Boiler feed-pumps were invariably of the single acting plunger type, and either driven by belt or from the cross-head of the engine. It is obvious to the reader that neither of the pumps above described could be operatad while the main engine was shut down, and this fact led Mr. Worthington to experiment with a view to producing a pump that could be run independently of the main engine at any and all times with steam up, and at the same time embody within itself a complete steam engine, for be it understood, the first steam pump had a flywheel and eccentric and used its steam expansively, and was a single pump. But, after some years, the flywheel was deemed a cumbersome and unnecessary part of the pump and was discarded. This led to the invention of the duplex pump, and later on to the building of the direct acting single pump, as we find them to-day. When an engineer, or the owner of a steam power plant of any kind, contemplates putting in a new pump his mind runs at once to a steam pump—probably for the reason that he never saw, or heard, of any other type of pump—and this is the kind of pump he will buy and install regardless of the fact that a power pump would serve his purpose just as well, and at the same time be vastly more economical in the matter of steam, and consequently fuel, while the first cost would be much less. It is a well-known fact that the best designed, and the most carefully adjusted and packed steam pump is a most extravagant consumer of steam. Carefully conducted experiments and trials, by eminent engineers, have shown conclusively and unmistakably that steam pumps consume anywhere from 75 to 285 pounds of steam per horse power hour, the most common consumption of steam being not less than 190 pounds per horse power hour, or about 10 times the amount of steam necessary to develop an equal number of horse power in a high grade automatic cut-off engine. There are many plants now employing steam pumps, in which power pumps could be used to just as good advantage and show a vast saving in coal bills at the end of the year. If the pump were placed in the engine room it could be driven by belt, or by gearing, or a combination of both, and if placed outside at a considerable distance from the engine it could be operated by a rope drive. The argument usually advanced in favor of the steam pump, as a boiler feeder, is that the pump can be started at any time regardless of the engine. While this is undoubtedly true, it can be said in reply that an injector, or an inspirator will be found just as convenient in this respect, just as reliable and very much more

economical than a steam pump. In drawing this comparison, it may be well to remark that first-class injectors are now sold at prices so low, that as a matter of convenience and to provide against the breakdowns and "jim-jams" that steam pumps are subject to, every steam boiler should be provided with an injector. In a power pump, there is but one source of trouble—the water end—while in a steam pump there are two sources of trouble—the steam end and the water end, the former giving no end of trouble at times. When it is considered that the average 10-horse power steam pump will require at least 2,000 pounds of steam per hour to run it, and that the same size pump when driven by a high grade automatic cut-off engine will require but 200, or at the very outside 250 pounds of steam, it should not require much persuasion to decide in favor of the latter arrangement. It is not the object of this article to decry or to disparage the steam pump in toto; it may be termed a necessary evil, since there are conditions and locations requiring its use exclusively. It is only when it can be displaced by a power pump just as well as not, that its retention becomes a piece of folly. The best type of boiler feed pump is the so-called triplex pump, in which 3 plungers driven by a crank shaft—which cranks set at 120 each—deliver an unbroken stream of water. This pump is driven by belt and gearing with tight and loose pulleys on the driving shaft. With this pump there is very little or no wear on the boiler check valve, nor on any of the pump valves, for the reason that when the pump is started all of the delivery valves rise simultaneously and remain off their seats until the pump is stopped, when they seat themselves gently without any jar or hammer, so that they seldom require regrinding or renewal. On the other hand, with single acting pumps, the valves pound themselves out of shape in a few months, and they fare but little better in steam pumps.

Submarine Oil Beds.

For some time past the Russian authorities have been exploring the petroleum producing country round Baku, and the result of these investigations has substantiated the hypothesis of experts that these naphtha beds are not only to be found at Baku, but that they extend for some distance beneath the sea.

An attempt to utilize these submarine resources is seriously contemplated, especially on the coasts of Bibi-Eibat and the island of Swjitoi. The depth of water at the former place ranges from 14 to 50 feet, and at the latter to about 39 feet.

The most serious problem that confronts the government is how to tap these submarine deposits without endangering the land supplies and public property and life.

The plant, such as reservoirs, pumping stations and power stations, must necessarily be similar to those employed on shore.

The difficulty of transporting the naphtha is very complex. Small boats could not be employed owing to the large quantities of sand which the fountains invariably throw up, while the utilization of steam vessels in a naphtha-laden atmosphere would be fraught with considerable danger.

The only means of solving the problem is by inclosing the area with a sea wall, but as such a reclamation scheme could be only undertaken at tremendous expense, and as the value of the oil beneath is purely suppositious, both in quantity and quality, the completion of such elaborate works might prove unremunerative.

As a tentative effort to discover the value of these submarine deposits, the government suggests that Romany Lake, one of the centers of Baku, should be laid dry and the soil tested. Several petroleum firms have made offers for this concession, but as none of them has been deemed sufficiently high, the government intends to empty the lake at its own expense and to let the area thus recovered, in the usual way.

If the experiment should prove successful and the oil sufficiently rich and abundant, the other schemes would then probably be undertaken.

THE proprietors of the Mobile (Ala.) Gas Light and Coke Company have issued the following notification to the residents: "On and after October 1st the price of illuminating gas will be $2 per 1,000 cubic feet, less a discount of 10 per cent., when bills are paid at the office of the Company on or before the 10th of month following service; and for fuel gas, $1.50 per 1,000 cubic feet, less a discount of 10 per cent., when paid under same conditions. In order to obviate delay in installing ranges, heaters and services, we respectfully request the many anticipated additional patrons to place their orders for same at earliest date possible."

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MESSRS. ALFRED E. FORSTALL and George W. Frank, of New York, have formed a partnership, under the firm name of Forstall & Frank, for the purpose of following in a general way the business of constructing gas and electric lighting plants, or the purchase of existing properties of such nature, with a view to their re-equipment and extension.

MR. THOMAS D. MILLER, General Manager of the Dallas (Tex.) Gas and Fuel Company, incloses, under date of September 6th, the following copy of a letter sent by him to the Editor of *The Southwest*, Houston, Tex., which explains itself: "There appeared, in your July issue, an article by Mr. Wm. E. Kennedy, C.E., on 'Oil as Fuel,' in which a certain Mr. Miller was accredited with the statement that 'The lignites gave 2.50 to 2.75 cubic feet of gas, of 14 or 15-candle power, per pound; Laredo coal but 5 cubic feet, of 22-candle power gas, per pound, and Corsicana oil 5.50 to 5.75 cubic feet, of 32-candle power gas, per gallon.' As these figures very much resemble those given by me in a paper[1] read before the 1898 meeting of the Western Gas Association, and published in the issue of the AEERICAN GAS LIGHT JOURNAL dated June 13th of that year, I take the liberty of correcting the foregoing statement by giving the exact language of my paper. That which I said was: 'As a gas oil it Corsicana oil] gives very satisfactory results, our yield being from 5.50 to 5.75 candles per gallon of oil used, and as high as 32-candle power gas has been made.' The process of gas making used was the Lowe water gas process, and the plant was erected by the United Gas Improvement Company, of Philadelphia. The Pintsch gas plants of Texas have been using Corsicana oil now for some time. They are making pure oil gas, and I am informed are getting 70 cubic feet of gas of 50-candle power or more."

THE gas rate in the San Francisco districts that are covered by the mains of the San Francisco Gas and Electric Company and of the Equitable Gas Light Company of that city, has been cut to 50 cents per 1,000 cubic feet. The rate that may be legally charged is $1.40.

THE combination of the gas, electric lighting and street railway interests of Mobile, Ala., which was to have been made effective the 1st inst., did not take place. The Mobile Street Railroad Company and the Mobile Light and Railroad Company have joined forces, as per the original programme, but the Mobile Gas Light and Coke Company and the Electric Light Company, of Mobile, are still independent concerns.

THE Union Savings Bank and Trust Company, of Cincinnati, has been named the transfer agent for the Cincinnati Gas and Electric Company.

MR. W. H. HOPKINS, President of the Baraboo (Wis.) Gas and Electric Light Company, died in Detroit, Mich., the morning of the 2d inst. He was in his 35th year.

THE Hildred Gas Company, of Uniontown, Pa., has been incorporated by Messrs. S. M. Graham, D. S. Richey, M. H. Bowman, McClellan Leonard, Jno. S. Douglas, B. H. Howell and H. F. Detwiler.

IT is quite evident that the parties who have taken over the gas lighting interests of Bridgeport, Conn., are the survivors of the syndicate that originally planned and built the plant of the Citizens Gas Company in that city—Messrs. Dieterich, Proal and others.

THE betterments on the plant of the Pulaski Gas Company, of Little Rock, Ark., are well underway, and will be completed by December 1st.

MR. W. J. HUFFMAN has been appointed Superintendent of the Paris (Ky.) Gas Light Company. President Cline proposes to make many improvements in the Paris plant.

"W. T. R.," writing from Mankato, Minn., under date of September 2d., says that the trading of the Mankato Gas and Electric Light Company is showing a wonderful increase. The demand for coke for use as a domestic fuel is urgent.

AT the annual meeting of the Oroville (Cal.) Gas, Electric Light and Power Company it was determined to ask for estimates for the rebuilding of the gas plant. The officers chosen were: Directors, J. W. Good-

1. "Recent Developments in Texas of Interest to Gas Men," by Thos. D. Miller.

win, C. M. Smith, L. J. Holton, C. H. Schievely, M. Marks, E. W. Fogg and C. W. Putnam; President, C. M. Smith; Vice-President, E. W. Fogg; Secretary, C. W. Putnam; Treasurer, Bank of Oroville.

THE proprietors of the Adams (Mass.) Gas Company have ordered the putting in force of the following schedule of selling rates: For lighting supply, $2 per 1,000 cubic feet, with 10 per cent. off for prompt payment; for a fuel and power supply, $2 per 1,000 cubic feet, with 20 per cent. off. The former net rates were $2 and $1.80 per 1,000, respectively.

MR. E. G. COWDERY says that gas will be supplied in Wauwatosa, Wis., by October 1st. As we have before noted, this supply will be furnished from the works of the Milwaukee Company. The conveying main is about 7 miles in length—that is, from the Third ward works of the Milwaukee Company to the Wauwatosa line.

THE officers recently selected to manage the affairs of the Malden and Melrose (Mass.) Gas Company are: Directors, E. J. Stevens, E. O. Holmes, Vinton W. Mason, E. N. Foss, E. A. Hildredth, F. A. Chandler, R. R. Robinson and S. E. Benson; President, F. A. Chandler; Vice-President, R. R. Robinson; Treasurer, E. C. Dolly; Clerk, Vinton W. Mason.

A CORRESPONDENT in Dover, N. H., forwards the following: "The Brattleboro (Vt.) Gas Light Company has engaged an engineer to make surveys and draw suitable plans for a dam to be erected about a mile from the mouth of the West river. As soon as the plans are completed and accepted, contractors will be asked to bid for the contract of erecting a 33-foot dam, according to specifications. The flowage will cover about 50 acres, and is expected to give a horse power of about 500, though engineers differ as to the power that the situation affords. After looking all over the points of vantage offered for improvement, this one has been selected as the most available and practical. All rights incident to the use of the location have been acquired, and now nothing stands in the way of the early realization of the plans of the promoters. The only objection to the location is expressed in the opinion of a well-known engineer, who is acquainted with the situation, that not so much power can be acquired as the promoters expect. It is a well-known fact that at certain seasons of the year West river does not carry much water in its course, and at those times there would be a consequent serious lack of power, if the stream is depended upon to furnish a certain amount. This season has been an exceptional one, in that a good stream of water has been flowing most of the time. There are seasons, however, when the flow is reduced to the minimum that might cause considerable trouble. It is expected that only about $50,000 will be required for the contemplated enterprise, and this will be furnished by Brattleboro people."

MR. O. E. CLARK, as Manager of the Napa (Cal.) Gas and Electric Company, has issued the following rate schedule—the gas schedule is effective on consumption, since August 1st, and that for electric lighting is to rule from the 1st prox.:

"*Gas Service.*—For illuminating purposes, $3.00 per 1,000 cubic feet; for fuel use $2.50 per 1,000. Discount, 50 cents per 1,000. Minimum charge for gas meter service, 50 cents per month. Discounts are allowed only when bills are paid at Company's office, on or before the 10th day of each month, for service supplied during the preceding calendar month.

"*Electric Service.*—Commercial: 16-candle power lights, per month: One or 2, 80 cents each; 3 to 5, 75 cents each; 6 or over, 70 cents each. Residences: 16-candle power lights, per month, 1, 2 or 3, $1.30 per month; 4, $1.70; 5, $2; 6, $2.35; 7, $2.70; 8, $3.05; 9 or 10, $3.50; each additional light 35 cents. Eight-candle power lights are charged for on the following basis: Three 8-candle power lights equal two 16-candle power lights; discount, 10 cents per each 16-candle power light. Electric current, meter measurement, 12 cents per 1,000 watts; discount, 2 cents per 1,000 watts. Minimum bill for meter measurement, $2 per month. Arc lights, $10 per lamp per month; discount, $2 per lamp per month. Fan motor service, $8 per year, net, payable in advance. All rates are based on annual consumption payable monthly. All rates are for electric current and gas only, and do not include incandescent lamps or gas mantles. Incandescent electric lamps, 8 and 16-candle power, 25 cents each, less discount of 5 cents per lamp for cash on counter. Gas and electric service installed free of charge. Gas stoves, ranges and heaters sold at cost."

THE present advance in the shares of the Louisville (Ky.) Gas Company, which are in goodd emand at 110 to 112, is not to be attributed to any dickering for combination with the opposition Company. The real reason for the advance is the great increase in the Company's output, the demand for gas on fuel account being really remarkable. The Company now has 6,800 ranges on its lines.

THE handsome new plant of the Taunton (Mass.) Gas Company, of Weir Village, is in satisfactory operation, much to the relief and comfort of the Company's clever and well liked agent, Mr. Henry B. Leach.

A RATHER queer legal preceeding is reported from Minneapolis, Minn., in the suit recently instituted by the Ford Roofing Company against the Minneapolis Gas Company to recover $38,250 damages for alleged breach of contract. The complaint declares that defendant entered into a contract with the plaintiff whereby the Ford Company was to have the Gas Company's entire output of tar at a certain fixed price. This contract it is claimed the defendant violated on January 1, 1900, by refusing to sell 75,000 gallons of the product then on hand. Later, it is alleged, the Gas Company made a contract for the sale of the tar product produced during 1900 with a local firm, in spite of the fact that the Ford Roofing Company was to have the preference in making the contract for 1900, provided its bid was as high as any other bid submitted.

MR. CHARLES D. WOODRUFF, former Superintendent of the Citizens Gas Company, of Bridgeport, Conn., who is to assume charge of the engineering division of the schemes of a certain syndicate that proposes to operate gas and electric lighting plants and street railways in Havana, Cuba, was recently banqueted by a party of friends. The spread was laid in Stickles' Bohemia Cafe, Bridgeport, and the presiding genius was Mr. Lyman M. Turney, former City Treasurer of Bridgeport. The affair was in every sense enjoyable, and Mr. Woodruff goes to the field of his new labors in the certainty that he has many friends in Bridgeport.

WE understand that Mr. H. D. Walbridge "and others" have applied for a franchise under which to operate a gas plant in Detriot, Mich. They propose to sell gas at 70 cents per 1,000 cubic feet, for all purposes. It is not likely that their petition will be accorded favorable action.

IT is quite certain that the plant and franchises of the Wilmington (Del.) Coal Gas Company are about to change hands, and we are sorry to have to make the announcement, for its record in the history of the gas business of America is that of a company that, in serving its owners, never unheeded the rights of its customers. A bid of $116 for each share of the par value of $50 was made by a responsible concern, and its reception was met by the preparing of the following circular which has been sent to each shareholder:

"September 3d, 1901.—To the stockholders: A cash offer is made for all or any part of the stock of this Company; not less, however, than two-thirds of the whole.

"The price offered is $115 per share, with $1 additional per share, to be allowed the sellers as an estimated accrued dividend at the date of payment. The delivery and payment to be made on or before October 1st, 1901, in this city. Many circumstances have prompted the management to approve of the proposed sale, and the Directors have unanimously agreed to accept that offer for themselves, and parties they represent, and now desire your prompt consideration of the proposal. Please notify me before the 10th inst., on the inclosed blank, of your willingness to join in the sale or otherwise, as the owners of 8,000 shares must assent to hold the offer good.—Respectfully, EDWARD BETTS, President."

THIS offer and its acceptance are in odd contrast with the usually quiet, dignified and safe manner in which the affairs of the Wilmington Company have been conducted for over 2 score of years. Perhaps Mr. George S. Capelle, Vice-President of the Company, could better than anyone else explain the change of front that has occurred; but, whether so or not, in our opinion and of our belief, it remains that, at the price of $116 for each half share, the purchasers have secured a bargain. We might further say that it is in line with reason to think and believe that those who decline to join the majority in the sale will get more than $116 later on.

WE understand that the plant of the Gloucester City (N. J.) Gas Light Company, which was shut down when it came into the possession of the South Jersey Gas, Electric and Traction Company, is to be again put in action.

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

THOS. J. CUNNINGHAM,
ELBERT P. CALLENDER,
EDITORS.

MONDAY, SEPTEMBER 16, 1901.

The Market for Gas Securities.

The act of the miserable scoundrel, whose dastard work placed the President of the United States in the direst peril of his life, resulted in a general unsettling of the business of the country, and at the close of the market to-day (Friday) marked losses all through the general list were recorded. Consolidated gas shows a decline of substantially 10 points for the week, and Peoples Gas Light and Coke, of Chicago, is 5 points lower. Of course, save for the moral effect of the assassin's work, the illness of the President should not affect industrial stocks, particularly such shares as those contained in the gas group, but the traders for the decline lose their delicate perceptions whenever calamity may be turned to profit.

There is no particular change in the gas situation as a whole, which continues remarkably safe and strong the country over. So investors may rest assured that should the worst come in the death of our President, the burdens of duty put down by him will be raised and carried on by others equally devoted to the principles which he so manfully and successfully strove to uphold.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

SEPTEMBER 16.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	215½	216½
Central Union, Bonds, 5's.	3,000,000	1,000	109	110
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	115	118
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	305	315
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	..	..	..
New Amsterdam Gas Co..				
Bonds, 5's	11,000,000	1,000	107¾	108
Northern Union, Bonds, 5's.	1,250,000	1,000	106	108
New York and East River..				
Bonds 1st 5's	3,500,000	1,000	111	115
" 1st Con. 5's	1,500,000	..	109	111
Richmond Co., S. I.	348,650	50	100	..
" Bonds	100,000	1,000	103	..
Standard	5,000,000	100	135	..
Preferred	5,000,000	100	158	..
Bonds, 1st Mortgage, 5's	1,500,000	1,000	118	..
Yonkers	299,650	500	120	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	205	217
" " Bonds (5's)	15 000,000	1,000	118	119
Bay State	50,000,000	50	¾	⅞
" Income Bonds	2,000,000	1,000	.	75
Binghamton Gas Works..	450,000	100	90	40
" 1st Mtg. 5's	500,000	1,000	92½	95
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	6	8
" " Bonds, 5's	5,250,000	1,000	69	72
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Central San Francisco	2,000,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati Gas & Elec. Co.	29,500,000	100	104⅛	104¾
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	106	107
Columbus (O.) Gas Lt. & Heating Co	1,682,780	100	60	65
Preferred	3,026,500	100	84	86
Consumers, Jersey City Bonds	600,000	1,000	102	103
Consumers, Toronto	1,700,000	50	215	216
Consolidated, Baltimore	11,000,000	100	63¾	65
Mortgage, 6's	3,600,000	..	..	118
Chesapeake, 1st 6's.	1,000,000	..	..	..
Equitable, 1st 6's.	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	12	14
" Con. Mtg. 5's	380,000	1,000	81½	83
Consolidated G. & E. Co.'s., Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co	4,825,500	50		89
" Prior Lien 5's	5,603,000	1,000	99½	100
Detroit Gas Co., 5's	381,000	1,000	89	89½
" Inc. 5's	16,000	100	94	94½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	34	38
Fort Wayne	2,000,000	..	..	.
" Bonds	2,000,000	..	54	58
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	102	104
Hartford	750,000	25	240	250
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	50	60
" Bonds, 6's	2 650,000	..	99½	101
Jackson Gas Co	250,000	50	65	70
" 1st Mtg. 5's	290,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	85	95
Preferred	2,500,000	100	100	102
Bonds	10,000,000	1,000	..	108½
Lafayette Gas Co., Ind.	1,000,000	100		60
Bonds	1,000,000	1,000	48	55
Louisville	2,570,000	50	110	120
Madison Gas & Elec. Co.				
" 1st Mtg. 6's	350,000	1,000	102½	108
" 6 per cent. scrip, due 1910	100,000	25	87	89
Montreal, Canada	2,000,000	100	182	184¾
Newark, N. J., Con. Gas Co	6,000,000	..	..	55
Bonds, 6's	4,600,000	..	..	103
New Haven	1,000,000	25	290	325
Nashville Gas Lt. Co.	1,000,000	100	110	..
Oakland, Cal.	2,000,000	..	46	47
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	107¾	107⅛
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
2d "	2,500,000	1,000	104	
Rochester Gas & Elec. Co.	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	46	46¼
St. Paul Gas Light Co	1,500,000	100	60	63
1st Mortgage 6's	650,000	1,000	82	85
Extension, 6's	600,000	1,000	..	..
General Mortgage, 5's	2,465,000	1,000	86	87
St. Joseph Gas Co.				
" 1st Mtg. 5's	751,000	1,000	93	96
Syracuse, N. Y.	1,750,000	100	16	17
Bonds	1,612 000	1,000	91	93
Washington, D. C	2,600,000	20	302½	303¾
First mortgage 6's	600,000	..	..	..
Western, Milwaukee. Bonds, 5's	4,000,000	..	106	108
Wilmington, Del.	600,000	50	232	..

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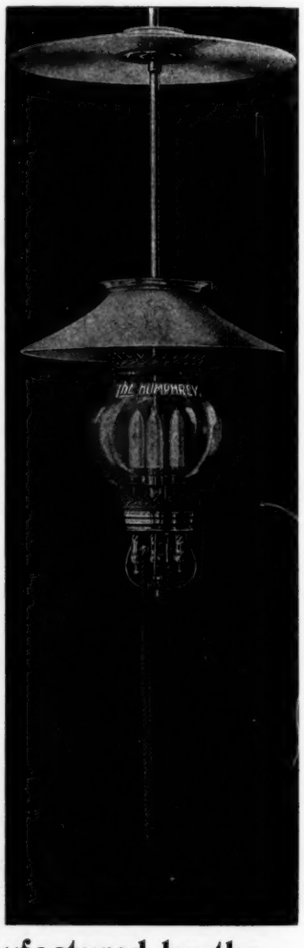

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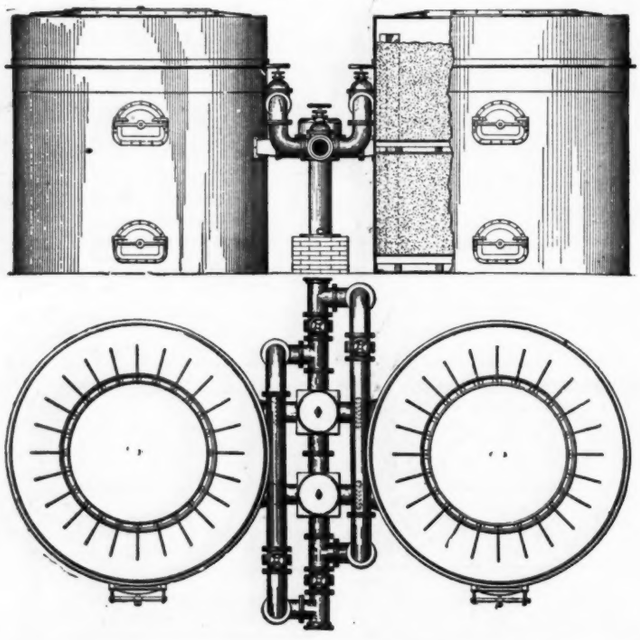

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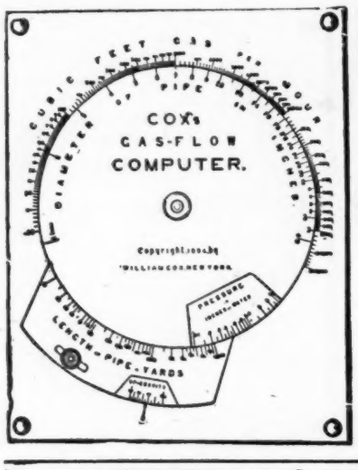

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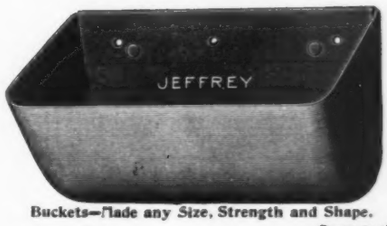

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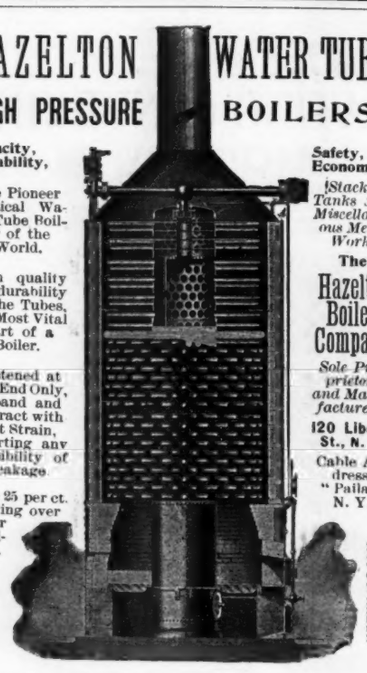

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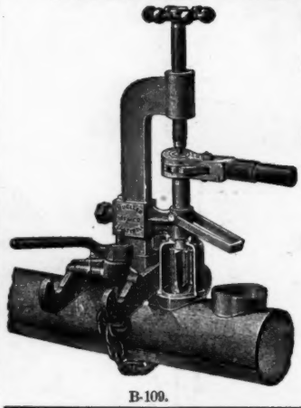

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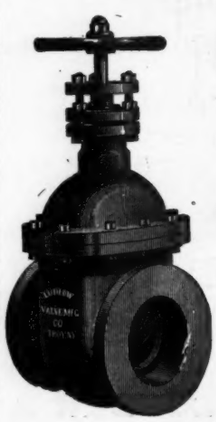

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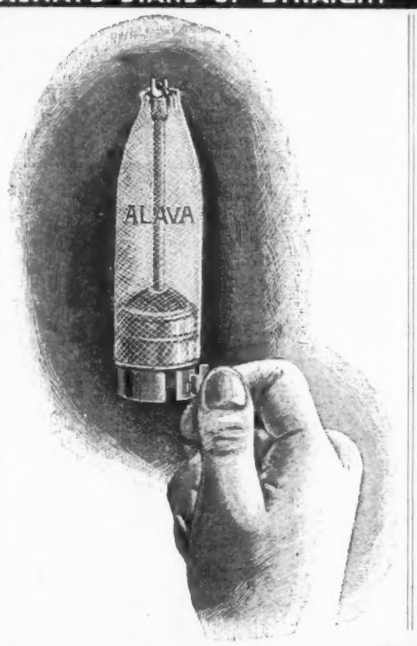

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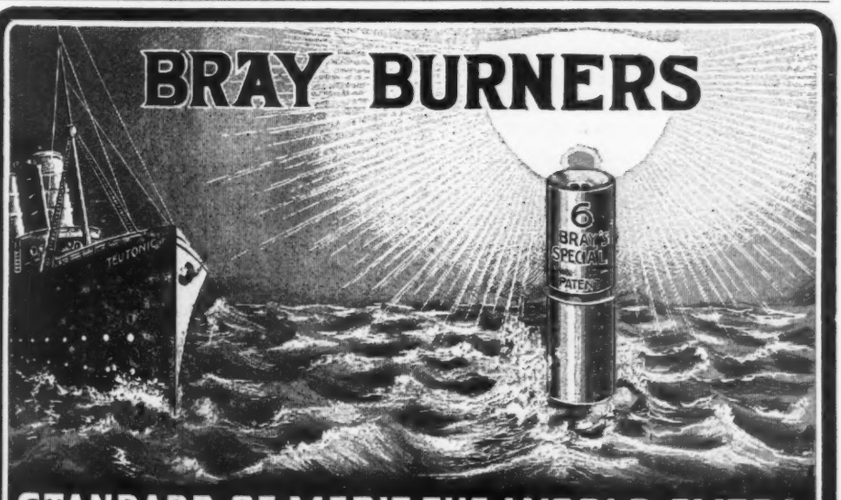

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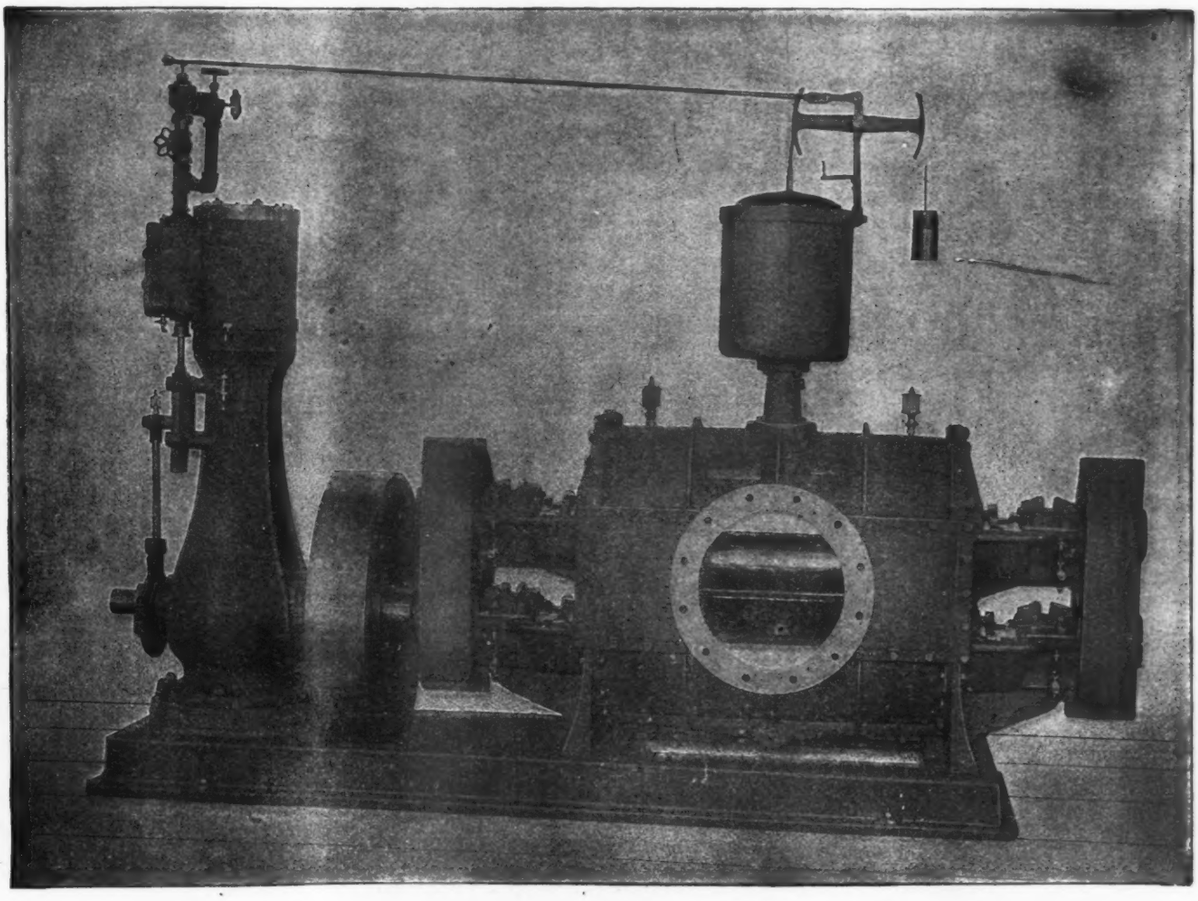

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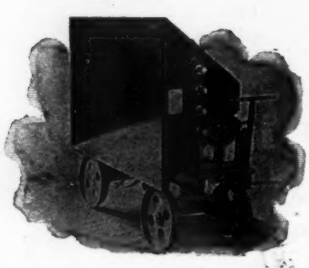

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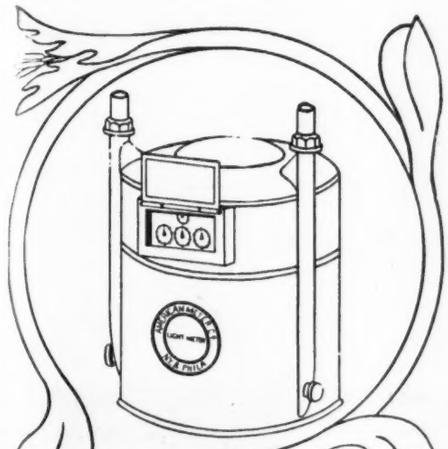

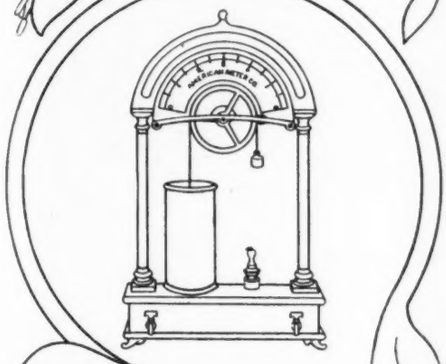

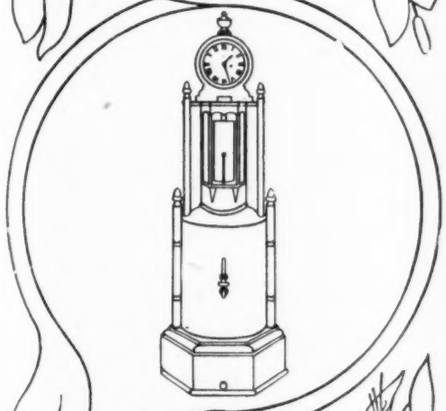

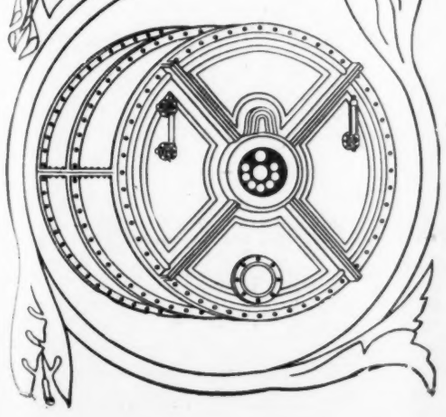

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NEW YORK AND PHILADELPHIA,

CHICAGO, ST LOUIS,

SAN FRANCISCO.

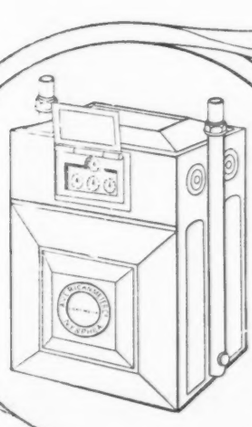
PUBLIC LIGHTING TABLE.

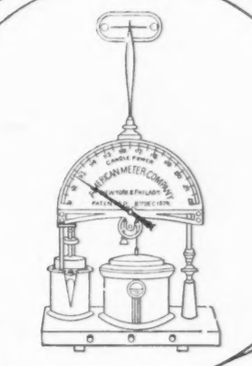
OCTOBER, 1901.

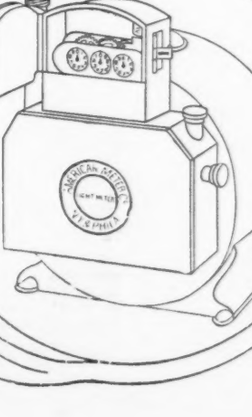
Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
				P.M.	A.M
Tue.	1	6.10 PM	9.10 PM	5.30	5.00
Wed.	2	6.10	10.00	5.30	5.00
Thu.	3	6.10	11.00	5.30	5.00
Fri.	4	6.10 LQ	12.10 AM	5.30	5.00
Sat.	5	6.10	1.10	5.30	5.00
Sun.	6	6.00	2.10	5.30	5.00
Mon.	7	6.00	3.10	5.30	5.00
Tue.	8	6 00	4.20	5.20	5.10
Wed.	9	6 00	5.00	5.20	5.10
Thu.	10	6.00	5.00	5.20	5 10
Fri.	11	6.00	5.00	5.20	5.10
Sat.	12	6.00 NM	5.00	5.20	5.10
Sun.	13	5.50	5.10	5.20	5.10
Mon.	14	5.50	5.10	5.20	5.10
Tue.	15	5.50	5.10	5 10	5.20
Wed.	16	5.50	5.10	5.10	5.20
Thu.	17	7.40	5.10	5.10	5.20
Fri.	18	8.30	5.10	5.10	5 20
Sat.	19	9.30	5.10	5.10	5.20
Sun.	20	10.30 FQ	5.20	5.10	5.20
Mon.	21	11.30	5.20	5.10	5.20
Tue.	22	12.30 AM	5.20	5.00	5.30
Wed.	23	1.40	5.20	5.00	5.30
Thu.	24	2.50	5.20	5.00	5.30
Fri.	25	4.00	5.20	5.00	5.30
Sat.	26	No L.	No L.	5.00	5.30
Sun.	27	No L. FM	No L.	5.00	5.30
Mon.	28	No L.	No L.	5.00	5.30
Tue.	29	5.30 PM	7.50 PM	4.45	5.35
Wed.	30	5.30	8.50	4.45	5.35
Thu.	31	5.30	9.50	4.45	5.35

TOTAL HOURS LIGHTING DURING 1901.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	220.10	January	423.20
February	192.30	February	355.25
March	180.00	March	355.35
April	158.30	April	298.50
May	140.40	May	264.50
June	135.40	June	234.25
July	138.00	July	243.45
August	156.20	August	280.25
September	174.40	September	321.15
October	202.30	October	374.30
November	220.40	November	401.40
December	241.30	December	433.45
Total, yr.	2161.10	Total, yr.	3987.45







NEW YORK, 33 Nassau Street. PHILADELPHIA, Broad and Arch Streets. CHICAGO, Foot of Orleans Street. BOSTON, 624 Tremont Building.
CLEVELAND, 809 Cuyahoga Building. ST. LOUIS, 712 Roe Building. SAN FRANCISCO, 712 Polk Street.

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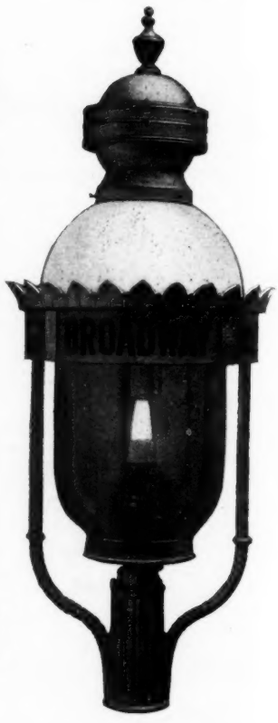

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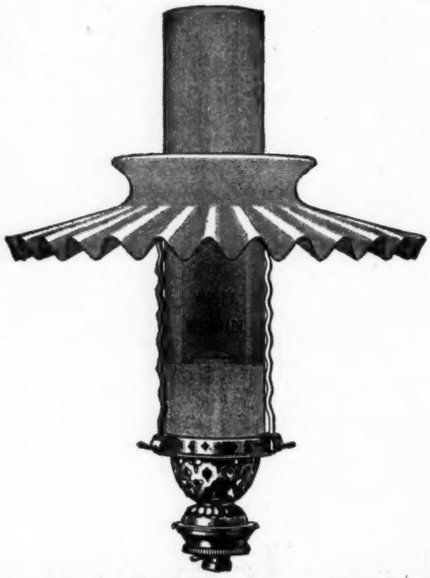

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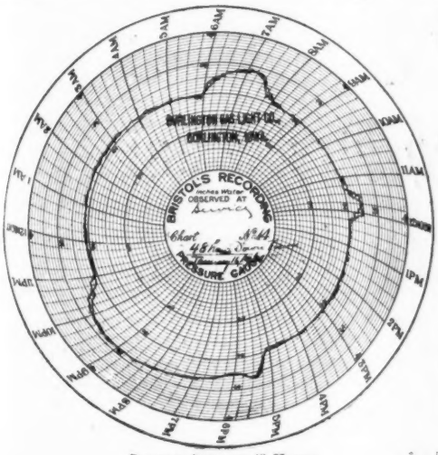

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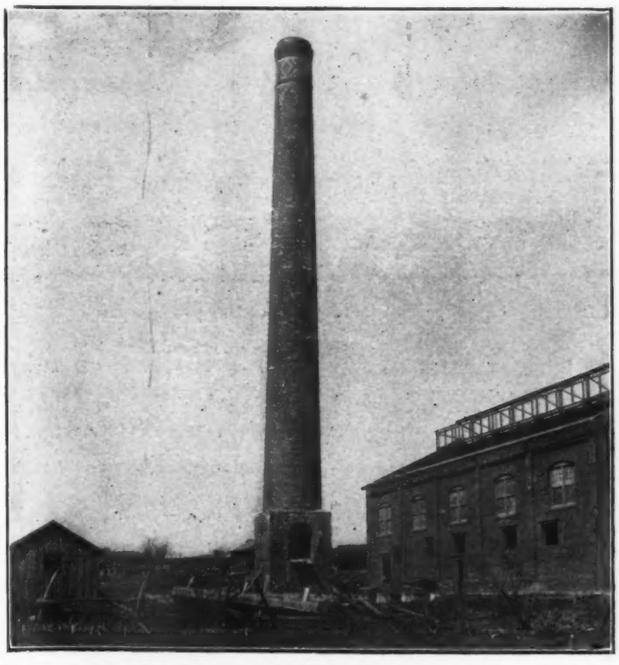

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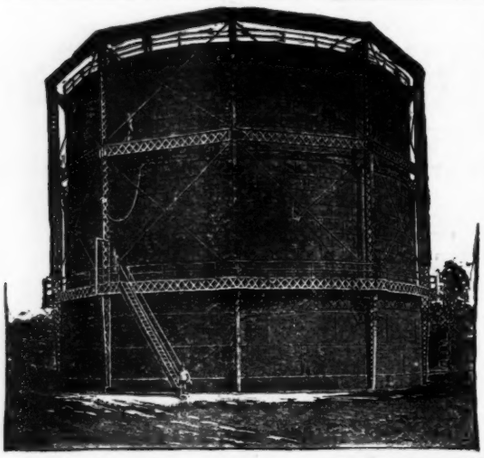

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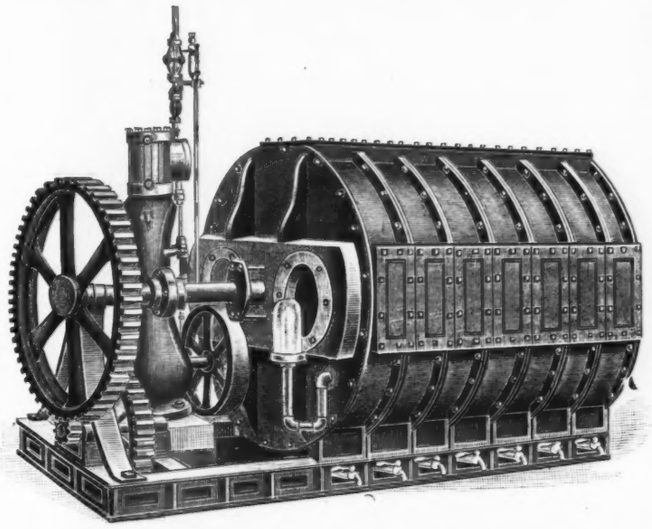

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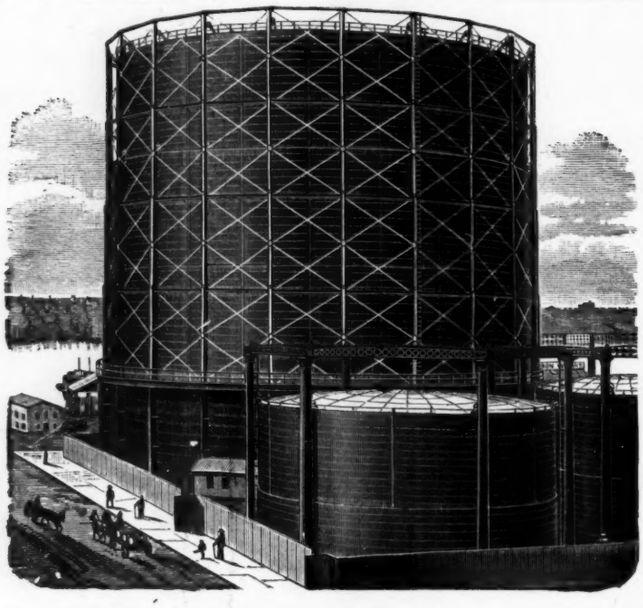

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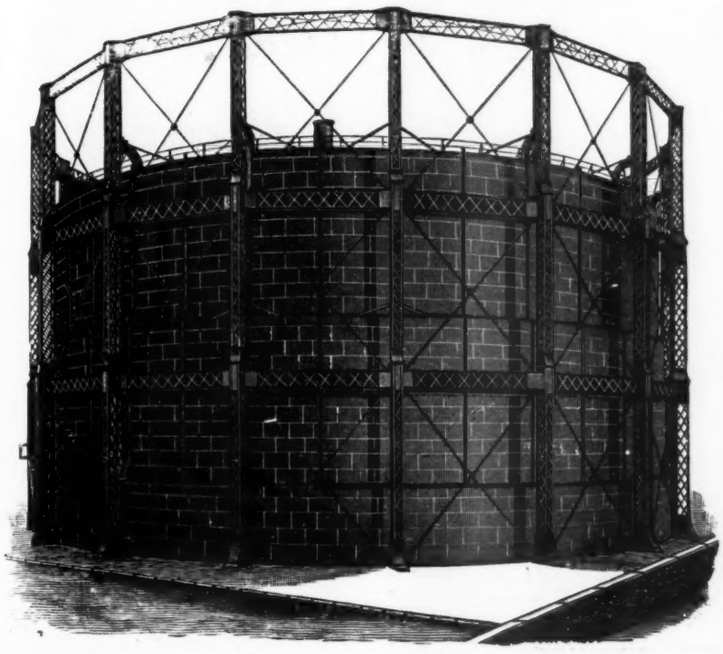

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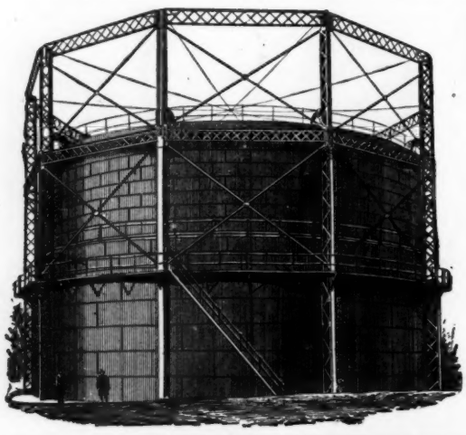

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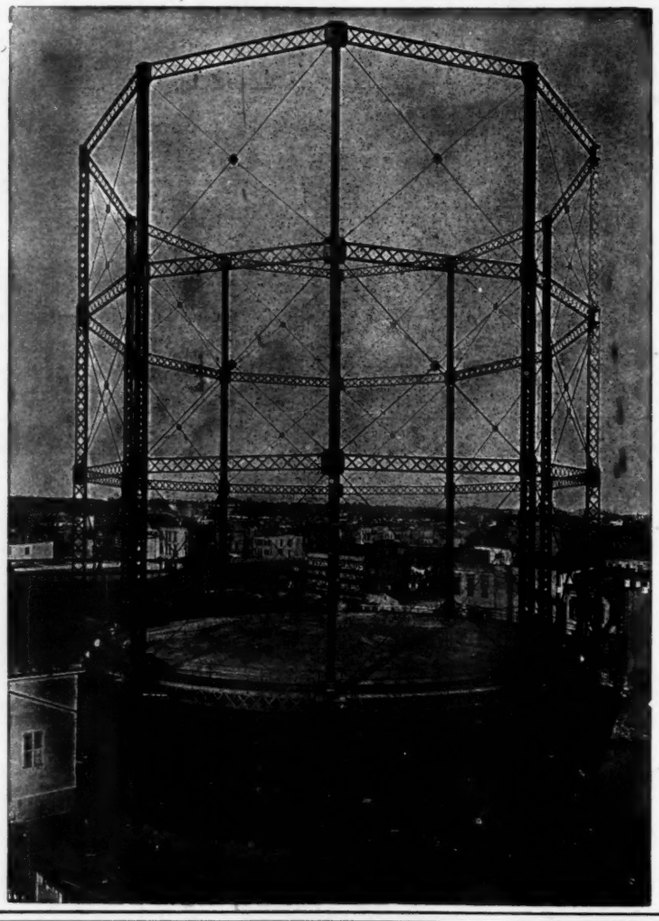

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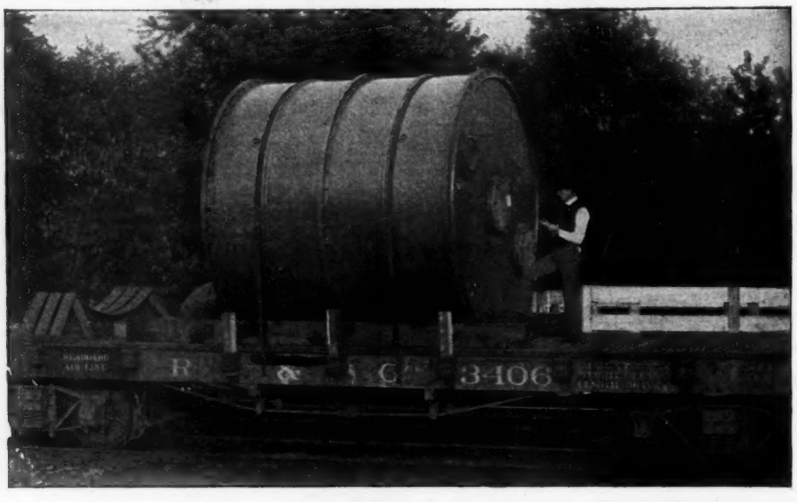

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